PORTAGE LAKE LIFT BRIDGE ELEVATOR MAINTENANCE IN THE CITIES OF HOUGHTON & HANCOCK, HOUGHTON COUNTY

BID PROPOSAL

ITEM OF WORK	APPROX. QTY	UNIT	UNIT PRICE	BID AMOUNT
North & South Elevators 2027 1st Quarter Maintenance	1	LSUM		
North & South Elevators 2027 2nd Quarter Maintenance	1	LSUM		
North & South Elevators 2027 3rd Quarter Maintenance	1	LSUM		
North & South Elevators 2027 4th Quarter Maintenance	1	LSUM		
North & South Elevators 2027 Annual No Load Test	1	LSUM		
North & South Elevators 2027 Change the Rescue Lowering Hydraulic Oil	1	LSUM		
One Non-Routine Maintenance Service Visit	1	LSUM		
One Emergency Maintenance Service Visit	1	LSUM		
Parts Replacement Allowance	5,000	Dlr	$1.00	$5,000.00
			TOTAL BID	

THIS PROJECT WILL BE AWARDED TO THE CONTRACTOR WITH THE LOWEST TOTAL BID. THE COMPLETED WORK WILL BE PAID FOR BASED ON THE COMPLETED QUANTITIES FOR EACH ITEM AND THE ITEM'S UNIT PRICE.

TOTAL BID: _____

COMPANY NAME: _____

ADDRESS: _____

AUTHORIZED SIGNATURE: _____

DATE: _____

The Michigan Department of Transportation reserves the right to reject any and all bids.

SPECIAL NOTICE

Prior to the award of the contract, the Contractor shall file with the Michigan Department of Transportation's Ishpeming Transportation Service Center located at 100 S. Westwood Drive, Ishpeming, MI 49849:

- General Liability Insurance
- Workman's Compensation Insurance
- Owners Protection Insurance

Insurance: The Contractor will be required to furnish a certificate of insurance showing they have complied with Section 107.10 of the Standard Specifications for Construction. Form 1304A, annexed hereto, shall be used for certifying insurance.

MICHIGAN
DEPARTMENT OF TRANSPORTATION

PROGRESS CLAUSE CS 31012

PORTAGE LAKE LIFT BRIDGE ELEVATOR MAINTENANCE IN THE CITIES OF HOUGHTON & HANCOCK, HOUGHTON COUNTY

PROGRESS CLAUSE: After receiving Notice of Award, start work on the date approved by the Engineer. In no case, shall any work be commenced prior to receipt of formal notice of award by the department.

The North & South Elevators 2027 1st Quarter Maintenance shall be completed no later than March 31, 2027.

The North & South Elevators 2027 2nd Quarter Maintenance shall be completed no later than June 30, 2027.

The North & South Elevators 2027 3rd Quarter Maintenance shall be completed no later than September 30, 2027.

The North & South Elevators 2027 4th Quarter Maintenance, Annual No Load Test, and Changing the Rescue Lowering Hydraulic Oil shall be completed no later than December 31, 2027.

Failure to meet the above-mentioned completion date and work date requirement shall result in liquidated damages as described in Section 108.10 of the Standard Specifications for Construction.

The low bidder(s) for the work covered by this proposal will be required to meet with Department representatives to work out a detailed progress schedule. The engineer will arrange the time and place for this meeting.

Failure on the part of the contractor to carry out the provisions of the Progress Clause, as established, may be considered sufficient cause to prevent bidding future projects until a satisfactory rate of progress is again established.

The low bidder(s) for the work covered by this proposal may be required to meet with department representatives for a post-construction review, as directed by the Engineer. The MDOT-designated representative will schedule the meeting.

ISH/KPF 10/29/26

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PROJECT LOCATION

The Michigan Department of Transportation (MDOT) is requesting quotes for a Quarterly Elevator Maintenance and a Lubrication Service of the two rack and pinion elevators on the Portage Lake Lift Bridge in Houghton, Michigan. This bridge is located at the US-41/M-26 crossing between the cities of Houghton and Hancock in Houghton County, Michigan.

The Facility Address is:

Portage Lake Lift Bridge
200 Bridge Street
Houghton, MI 49931

PROJECT SPECIFICATIONS

The Contractor shall provide all personnel, parts, tools, equipment, supporting services, etc. for on-the-job preventive maintenance examinations and lubrication of the rack and pinion elevators.

This maintenance service shall be consistent with that prescribed by the rack and pinion elevator manufacturer as well as ANSI/Code A-17-1 ASME Standards and the applicable Michigan elevator rules and code and shall include such additional services as the conditions of the individual rack and pinion elevators warrant:

- For safe efficient operations
- To meet the requirements of the elevator regulation enforcement authorities
- To extend the service life of the rack and pinion elevators
- To minimize maintenance down time and trouble call backs to rates comparable to, or no higher than, the lowest occurrence rates of the elevator maintenance industry.

The Contractor shall use trained employees directly employed and supervised by their firm that are elevator journeymen with a current State Journeyman's License.

The Contractor must provide the following. The following generally outlines the type of service to be provided. It does not by inclusion or exclusion or in any other way limit or otherwise restrict or preclude any specific elements of service necessary to provide safe and efficient service.

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- The Portage Lake Lift Bridge has two (2) rack and pinion elevators which are Tower Elevator Systems Incorporated TRAC-CAB Industrial Rack and Pinion Elevator Systems with State serial number 9965233 for the South tower and 9965234 for the North tower.
- Examine, test, adjust, and lubricate elevators as required. If conditions warrant, perform an analysis, provide recommendations, and generate an estimate to repair or replace all components integral to the existing rack and pinion elevator system.
- The Contractor must at a quarterly maintenance perform the following:

1. Clean and inspect all Elevator Systems and Parts

2. Closely inspect all Guide Wheels for unusual wear patterns.

3. Closely inspect Rack and Gear connection for patterns of uneven wear or misalignment according to the Operation Manual Section 9.4 Rack and Pinion Gear Inspection Procedure.

4. Closely inspect the Counterweight System; including top sheaves, support cables, attachment points and guide track (if applicable).

5. Examine all safety devices & governors.

6. Thoroughly inspect the Energy Chain cable and carrier, guide pans, and support channels.

7. Lubricate, but do not over lubricate, the Rack and Gear System with Graphite Based Dry Spray Lubricant (see Elevator Operation Manual for product information).

8. Test and Lubricate all Cab and Landing Door Mechanisms (use penetrating spray to lubricate and protect all moving parts)

9. Test Rescue Lower System

10. Check condition of UPS. Service or replace as needed.

11. Check the oil level in the hydraulic reservoir and add if necessary (Do Not Overfill)

12. Check the oil level in the gearboxes and add if necessary

13. Verify all safety signage is intact

11. Hoist ways shall be thoroughly cleaned as needed for safe and efficient elevator operations. Hoist way door hangers and interlocks shall be cleaned, adjusted, renewed, or repaired as needed, this includes removal of all pigeon debris.

12. The Contractor shall provide lubricants oils equal to or superior to those recommended by the manufacturer. Lubricants and oils shall be identified by label.

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13. It will be the vendor's sole responsibility to acquire the proper tools to provide the rack and pinion elevator service. The State will NOT be responsible to furnish any tools necessary to perform the rack and pinion elevator service.

14. Equipment shall be maintained in proper adjustment for safe and efficient operation. The rack and pinion elevator equipment shall be adjusted for smooth operation, accurate leveling and efficient door operation. Equipment shall function to accepted industry standards. Both rack and pinion elevators shall operate at original specification speed under any/all load conditions. Original specification information can be obtained from the Michigan Department of Licensing and Regulatory Affairs, Elevator Division, Lansing, MI. Dispatching systems shall be adjusted to reflect actual traffic conditions for maximum efficiency. Any changes in adjustments of dispatching or door open/close systems must have the approval of the Ishpeming TSC prior to the change except where the adjustment is necessary to bring operation back to last approved speed.

15. Barriers: The Contractor shall furnish, install, maintain as long as necessary, and remove when no longer required adequate barriers, warning signs, or lights at all open rack and pinion elevator hoist ways and other dangerous points throughout the work for protection of property, workmen and the public.

Barricades: The Contractor shall erect and maintain all hoist way barricades during the periods that a rack and pinion elevator is shut down. Barricades shall be in full compliance with rules and ordinances describing barricading and shall be removed when the hazard is no longer present.

16. Provide a paper service report form documenting maintenance services performed for each rack and pinion elevator and the total time expended, the cause of any problems and a list of any parts replaced. The completed form shall be signed by the senior licensed elevator mechanic performing or supervising the work. As a condition of payment for the related service, one (1) copy of this report will be submitted to the Bridge Operator on duty prior to leaving the facility for the service visit.

- The Contractor must at a 6-month maintenance interval (this would typically be done at the 2nd quarter and 4th quarter maintenance) perform the following:
  1. Perform Maintenance as noted above for a quarterly maintenance.
  2. Perform a drop test of the safety brake so that the brake comes into operation. Only specifically trained personnel can perform this operation.

- The Contractor must at an annual maintenance interval (this would typically be done at the 4th quarter maintenance) perform the following:

1. Perform Maintenance as noted above for a quarterly maintenance.
2. Perform all State required testing and reporting including the annual no load test.

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3. 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.

4. Testing of all Limit switches and all Normal and Emergency operating functions.

5. Perform Safety brake function test and document results.

6. Change the hydraulic lowering oil in the hydraulic oil reservoir.

7. Change the gearbox oil in the gearboxes per manufacturer's instructions.

8. Inspect all components under the Car Top Mechanical Enclosure Cover

9. Inspect and Re-Certify Fire Extinguisher.

- The Contractor must at a 3-year maintenance interval (this would typically be done at the 4th quarter maintenance in 2027) perform the following:
  1. Change the rescue lowering hydraulic oil.

- ~~The Contractor must at a 4-year maintenance interval (this would typically be done at the 4th quarter maintenance in 2028) perform the following:~~
  ~~2.~~ ~~Remove and send the safety brake for servicing by the manufacturer. To keep the elevators in operation a new safety brakes shall be installed while the brakes are being serviced.~~

- ~~The Contractor must at a 5-year maintenance interval (this would typically be done at the 4th quarter maintenance in 2029) perform the following:~~
  ~~1.~~ ~~Perform a complete system inspection and function proof test by a Certified Elevator Technician.~~
  ~~2.~~ ~~Perform all State required testing and reporting~~

All work on this project shall be according to the 2020 Standard Specifications for Construction and according to this log.

Estimated Mainline Quantities for Information Only

North & South Elevators 2027 1st Quarter Maintenance	1	LSUM
North & South Elevators 2027 2nd Quarter	1	LSUM

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Maintenance		
North & South Elevators 2027 3rd Quarter Maintenance	1	LSUM
North & South Elevators 2027 4th Quarter Maintenance	1	LSUM
North & South Elevators 2027 Annual No Load Test	1	LSUM
North & South Elevators 2027 Change the Rescue Lowering Hydraulic Oil	1	LSUM
One Non-Routine Maintenance Service Visit	1	LSUM
One Emergency Maintenance Service Visit	1	LSUM
Parts Replacement Allowance	5,000	Dlr

The item **North & South Elevators 2027 __ Quarter Maintenance** includes the costs for all travel costs including meals, lodging, travel time, and mileage and labor costs for the non-routine maintenance service work including fringe benefits.

The work items **North & South Elevators 2027 Annual No Load Test** and **North & South Elevators 2027 Change the Rescue Lowering Hydraulic Oil** include all labor costs for this work including fringe benefits. The work for these items must be done during one of the quarterly maintenance service visits to avoid travel costs.

The item **One Non-Routine Maintenance Service Visit** includes the costs for all travel costs including meals, lodging, travel time, and mileage and labor costs for up to 24 hours of onsite work for the non-routine maintenance service work including fringe benefits.

The item **One Emergency Maintenance Service Visit** includes the costs for all travel costs including meals, lodging, travel time, and mileage and labor costs for up to 24 hours of onsite work for the emergency service work including fringe benefits.

Parts Replacement Allowance

The Contractor shall provide recommendations for upgrades and will provide written estimates for any work not included in this agreement.

MDOT will provide $5,000 as a parts allowance for the purpose of performing repairs on the elevators located at the Portage Lake Lift Bridge to cover the cost of work that is beyond the scope of the quarterly maintenance and as requested by MDOT either through service calls or to perform work as required due to a LARA Correction Order.

Th parts allowance above is a yearly estimate for Non-Routine Maintenance and Repairs, exact quantities are unknown. The parts allowance may be adjusted (increased or decreased) yearly based on the actual costs to complete the Non-Routine Maintenance and Repairs.

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The Contractor will be reimbursed for parts at the Invoice cost (reflecting Discounts) plus a % Markup for Handling of Parts. The maximum markup for handling is 10%.

Schedule of Services

Within 30 workdays of award of contract, the contractor shall prepare and submit a detailed schedule, acceptable to the State, for the total proposed inspection and maintenance program over the year of the contract which includes the details of service for both special elevating devices.

The scheduled work shall include all maintenance tests and inspections required by law; recommended by the elevator device manufacturers; and as otherwise provided for in this contract.

The maintenance journeyman shall check in at the Portage Lake Lift Bridge Operators House upon arrival, and check out when leaving, providing the operator on duty with the service report form required in the records section below. The exception to this will be the 1st quarter inspection of each year when the contractor will need to coordinate that inspection with the Bridge Supervisor, located at the MDOT Houghton Maintenance Garage in Calumet, at least 2 business days' notice will be required prior to performing that inspection.

Labor

The contractor shall provide all necessary labor to perform repairs, supervise work, perform examinations, adjust equipment, and maintain records, conduct tests, answer trouble call backs and any other work required by the contract. The labor shall be elevator journeymen with a current State journeyman's license. Helpers may work on the site under the direct supervision of a licensed journeyman as allowed by law.

The contractor shall make every effort to provide a journeyman within 12 hours of travel time from the Portage Lake Lift Bridge and shall be available for any regular time or overtime work as required. The contractor shall provide supervisors to assist field personnel where necessary and shall supervise maintenance work on an ongoing basis. (Refer to emergency repairs for more information about this requirement.)

The State reserves the right to require the Contractor to replace and/or exclude any individual from any work in this Contract. Such request will be in writing with reasons defined. The State always reserves the right to require all contractor's staff to wear state provided identification when in a State facility. Such identification will be provided by and returned to the MDOT Contract Manager.

Parts

Parts are defined as all parts, components, and devices which wear, fatigue, or otherwise fail as a

result of normal usage or application of power and which must be adjusted, repaired, renewed or replaced for safe and efficient operation. This includes but is not limited to cables, wiring, controllers, switch gear, machines, motors, pumps, packings, pistons, safeties, reversing devices, motor-generators, commutators, field coils, bearing, worms/gears, rollers, shoes, hinges, signal light bulbs, sockets, push buttons, starters and ballasts.

The Contractor shall, test, adjust and maintain all parts needed or used on the special elevating device equipment. When a part needs to be repaired or replaced, the Contractor shall provide a written estimate to the project manager. The contractor shall not proceed with the installation until given authorization from MDOT. The quality of the parts used under this contract shall be equal to or better than the original parts provided by the special elevating device's manufacturer. Sufficient replacement parts shall be available and may be stored in the machine towers in metal part cabinets as directed by MDOT.

The Contractor shall provide expedited parts acquisition for any part which prevents a special elevating device from being in service. Any part not in the contractor's inventory shall be acquired by the most expedient means available. The State will not be subjected to any additional costs for reasons of acquisition of any part necessary to restore a special elevating device to service in the minimum achievable time, after authorization to proceed with the work is given.

The State is not liable or responsible for the cost of, or the security of, any parts stored on State property.

Hoisting cables and governor cables replacements shall meet all applicable codes and manufacturers specifications.

Wiring, Diagrams, Parts List and Parts Catalogs

Within sixty (30) days of execution of the Contract the Contractor shall analyze the completeness, adequacy and accuracy of all existing plans, specifications, maintenance instructions, wiring diagrams, and other data currently held by the State pertaining to the operation and maintenance of each elevator device. The Contractor shall identify any missing items and provide a written report covering the findings to the Ishpeming TSC.

If the Contractor identifies that certain plans, specifications, maintenance instructions, wiring diagrams, parts list, or parts catalogs are missing, MDOT will try to acquire the missing items. All plans, specifications, maintenance instructions, wiring diagrams, and other data are the sole property of the State and will be labeled as such.

At the end of this contract period, the contractor will be required to replace any missing plans, specifications, maintenance instructions, wiring diagrams, or any other data. The Contractor shall file and post all data for both elevator devices covered by this contract. Wiring diagrams are to be

filed in the machine room. Wiring diagrams are not to be removed from the Lift Bridge under any circumstances. All plans, diagrams, specifications, instructions MUST remain at the elevator device location during and at the expiration of this contract and are considered the property of the State.

All parts leaflets and books are to be systematically stored in appropriate metal cabinets along with maintenance manuals, spare parts, instructions, etc. All data relating to the elevator devices shall become the property of the State and shall not be removed at the expiration of this contract.

Tools

It will be the vendor's sole responsibility to acquire the proper tools to provide the special elevating device service. The State will NOT be responsible to furnish any tools necessary to perform the special elevating device service.

Lubricants

The Contractor shall provide lubricants equal to or superior to those recommended by the manufacturer. Lubricants shall be identified by label, and shall consist of worm gear oil, bearing oil, wire rope lubricant, hydraulic fluids, bearing grease, etc. Lubricants shall be manufactured for use with elevator equipment. A reasonable quantity of lubricants may be kept at the bridge and is stored must be stored in accordance with any applicable laws or codes in each machine room in a location agreed upon by the bridge operators.

Adjusting

Equipment shall be maintained in proper adjustment for safe and efficient operation. The elevator device equipment shall be adjusted for smooth operation, accurate leveling and efficient door operation. Equipment shall function to accepted industry standards. Both elevator devices shall operate at original specification speed under any/all load conditions. Original specification information can be obtained from the Michigan Department of Licensing and Regulatory Affairs, Elevator Division, Lansing, MI. Dispatching systems shall be adjusted to reflect actual traffic conditions for maximum efficiency. Any changes in adjustments of dispatching or door open/close systems must have the approval of the Ishpeming TSC prior to the change except where the adjustment is necessary to bring operation back to last approved speed.

Cleaning/Painting

The elevator device hoist ways, hoist way walls, hoist way pits, and all elevator device equipment located in hoist ways shall be always maintained in a clean condition, this includes all pigeon debris. The Contractor shall provide one cleaning of pigeon debris annually. Disposal of debris is the responsibility of the State. Equipment is to be painted to allow easy cleaning and eliminate any possibilities of metal deterioration. The machine room and all equipment therein including equipment cabinets, devices, controllers, selectors, machines, and all paintable parts shall be

painted regularly and maintained in a clean condition. All paint shall conform with the MDOT 2020 Standard Specifications for Construction Section 915 and shall match the existing color. Notify/coordinate any painting that will occur with the bridge operator on duty and when normal elevator operation can resume. Paint will need to be properly stored in accordance with all applicable codes and laws if left onsite.

Barriers/Barricades

Barriers: The Contractor shall furnish, install, maintain as long as necessary, and remove when no longer required adequate barriers, warning signs, or lights at all open elevator hoist ways and other dangerous points throughout the work for protection of property, workmen and the public.

Barricades: The Contractor shall erect and maintain all hoist way barricades during the periods that an elevator is shut down. Barricades shall be in full compliance with rules and ordinances describing barricading and shall be removed when the hazard is no longer present.

Tests

The Contractor shall notify the MDOT Project Manager prior to any testing taking place to ensure no problems arise. The Contractor shall conduct all State required tests such as but not limited to; pressure relief tests, buffer tests, full load safety tests, periodic tests, kinetic energy door closing pressure tests, test to determine leaking cylinders, piping, and fire alarm recall system. Tests shall be conducted in accordance with State laws, rules & regulations, as administered by the Department of Labor and Economic Growth, in effect upon execution of this contract and as implemented thereafter during the life of this contract. All tests, unless otherwise directed, shall be performed during regular work hours. Copies of all tests results shall be provided to the Ishpeming TSC. The Contractor shall immediately correct any deficiency, arising from inadequate maintenance, which causes a special elevating device to fail a legally required test or any inspection by the elevator regulation authority. The State will not be liable for any costs incurred in such correction or any resultant re-testing or re-inspection.

Emergency Service

Emergency service shall be provided when required.

The State will only pay extra for an Emergency Service when:
1. The necessity for the emergency work was not caused, or contributed to, by the Contractor.
2. The necessity is not a result of the Contractor's failure to adequately provide the services requested herein and is outside the scope of the work of the Contract.
The list of persons authorized to place emergency calls are as follows:

- Lead Bridge Operator/Operator on Duty
- Bridge Supervisor
- MDOT Contract/Project Manager

- Ishpeming TSC Operations Engineer
- Ishpeming TSC Manager

In the cases of personal injury involving the elevator devices or passengers being trapped in a elevator from the time a call back for emergency service is placed, the Contractor must have available workers on site within ten (10) hours travel time.

The journeyman shall fill out a service report form and leave one (1) copy of same with the bridge operator on duty describing the problem, why it happened, and the corrective action taken as well as a time ticket. The State will not be responsible for replacement of any part during an emergency call where such replacement arose from, or is contributed to, by any inadequacy of the Contractor's performance of this contract. The Ishpeming TSC may review and evaluate the reasons for excessive emergency calls and require corrective action.

Records

Within 30 days of execution of Contract the Contractor shall prepare, and upon the State's approval, place in use a service report form for documenting services performed. The form shall include and list the inspections, tests, and other services required by the elevator manufacturer(s), those required by law plus those deemed appropriate by the contractor and required by the contract. The form shall also show, as a minimum, the maintenance performed for each elevator device and the total time expended, the cause of any problems and a list of any parts replaced. It shall differentiate between routine maintenance work and emergency service. The completed form shall be signed by the senior licensed elevator mechanic performing or supervising the work. As a condition of payment for the related service, one (1) copy of this report will be submitted to the Bridge Operator on duty prior to leaving the facility on each service visit. A permanent record log will be maintained in the elevator device machine room in addition to any check chart utilized by the contractor.

Records are to be provided covering any changes to equipment or adjustments for the improvement of efficiency and safety. The Contractor is encouraged to recommend changes to equipment to improve safety and operational efficiency.

The Contractor's personnel must check in at the Bridge Operators House when arriving at the facility and shall notify the Operator on Duty of their presence. When leaving, personnel must check out. This procedure must also be used when answering emergency calls. The only exception is the 1st quarter of the year inspection as noted above.

At the end of each quarter, the contractor shall submit to the Ishpeming TSC a report of all activities/maintenance in such detail as may document adherence to the approved schedule. Also indicate if any major repair work is recommended for or was completed during the quarter.

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Examination of Premises

The Contractor shall become familiar with each special elevating device to be included in this contract and shall survey the components and systems to define the current status and adequacy of maintenance, if the Contractor would like to schedule an onsite visit, refer to: Working Conditions below.

Special Elevating Devices Removed from Service

In the event the elevator devices are removed from service for scheduled repairs or upgrade work, the Contractor shall do it's best to perform this work prior to the bridge startup in the spring.

Inspection

The Ishpeming TSC or their assigns may inspect the special elevating devices at various intervals independent of the Contractor. The purpose of this inspection will be for auditing and ensuring that the Contractor is providing preventative maintenance and/or repairs of the quality and timeliness anticipated, and required, by the Contract.

It will be the responsibility of the Contractor to notify the Ishpeming TSC of the start date and approximate finish date of the work. In case of any dispute arising between the Contractor and the Ishpeming TSC as to the manner of performing the work, the Ishpeming TSC shall have authority to suspend the work until the question at issue can be resolved.

In no instance shall any action or omission on the part of the Ishpeming TSC relieve the Contractor of the responsibility of performing the work in accordance with the Contract documents.

Security Screening

The State reserves the right to screen for the purpose of security all employees of the Contractor who will work on these premises. The Contractor must replace any prospective employees who are found to constitute security risks. The State further reserves the right to recommend reassignment of personnel deemed unsatisfactory by the State. Such employees, in either case, may not be assigned at any other State location.

Royalties, Patents, Notices, and Fees

Contractor shall give all notices and pay all royalties and fees. The Contractor shall defend all suits or claims for infringement of any patent rights and shall save the State harmless from loss on account thereof. The Contractor shall comply with all laws, ordinances, and codes applicable to any portion of the work.

Working Conditions

All work shall be done in accordance with all regulations governing the State Agency wherein the

work is to be performed and with minimum possible interference with the proper functioning of the activities of that State Agency. Materials, tools, etc., shall be confined so as not to unduly encumber the premises. The Contractor shall be held to have visited the site prior to submitting a bid for this contract and checked with the authorities the working conditions and the methods of carrying out the work and to have included in the contract amount all costs for meeting such working conditions. Normal work hours are 8:00 AM until 5:00 PM, Monday through Friday except for holidays. If the Contractor would like to schedule an onsite visit prior to bidding arrangements can be made with the Ishpeming TSC.

The Contractor shall comply with all security regulations and special working conditions as required by the agency. Access to and egress from the bridge and towers, and agency grounds shall be via routes specifically designated by MDOT.

Materials and Workmanship

Unless otherwise specified, all materials and workmanship shall be new and of the best grade of their respective kinds for the purpose. Whenever an article, material, or equipment is specified by name, a substitute of equal qualifications approved by the State may be used. All materials used shall be equal to or better than the original parts. All replacement parts shall be new and designed for proper and safe operation of the equipment. Workmanship shall be of the best quality and consistent with accepted elevator practices and difficult exterior conditions the elevators function in.

If any part of the Contractor's work depends for proper results upon existing work or the work of another contractor, the Contractor shall notify the Ishpeming TSC, before commencing work, of any defects that will affect the results. Failure to notify will constitute the acceptance of the conditions.

Good Order

Contractor shall enforce good order among all employees and shall not employ on the work any disorderly, intemperate, or unfit person or anyone not skilled in their assigned work.

State's Right to Do Work

A copy of any audits and/or inspection reports indicating unsatisfactory elevator conditions or contractor performance will be provided to the contractor. A meeting may be held with the contractor to review the conclusions of the audit or inspection report and to develop a plan of any necessary action. If the contractor disagrees with any items of the report or refuses to take action, the State may take appropriate independent action as follows:

1. In any matter affecting the health, safety or welfare of State employees or the public where following either written or verbal notification, the contractor refuses or neglects to correct the hazard the State may, without prejudice to any other available recourse or process, take such action as it deems necessary to assure safety and/or protect property.
2. In matters not affecting health, safety or public welfare, the State may obtain an analysis of the

issue by an independent consultant. Where the consultant confirms the State's position the State may then take any action necessary to correct the problem.

3. In either case where the State takes independent action, which is a required obligation of the contractor and which is subsequently determined to be either prudent or necessary, the total costs thereof will be assessed against any moneys to become due the contractor or otherwise recovered from the contractor.

4. The State reserves the right to use the contractor's estimates as a scoping and programming estimate to competitively bid any work considered non-routine.

5. At any time, the State may have a construction contract in place for work on the Portage Lake Lift Bridge, the State reserves the right that the State or it's Contractor may enter into an agreement with any qualified elevator company to provide additional service or work beyond the scope of this contract. If another elevator company is performing work the contractor chosen for this contract will coordinate and cooperate fully.

Clean Up

Contractor shall, always, keep the premises free from accumulations of waste material or rubbish caused by the contractor's employees or work. At the completion of the work, he/she shall remove all waste, tools, equipment, staging, and surplus materials from the structure and/or grounds and leave the work areas clean and ready for use.

State Ordered Repairs

The LARA Elevator Division may review the site and issue correction orders, the Contractor will provide recommendations and estimates to correct any issues noted.

Parts not included in monthly contract prices, shall be billed to the State at invoiced cost including shipping plus a markup of not more than 10% for handling charges.

Safety Regulations

The Contractor shall conform to the "General Safety Rules and Regulations" for the construction industry, as prescribed by the Construction Safety Commission, Department of Labor and Economic Growth, State of Michigan and the Occupational Safety and Health Standards of the U. S. Department of Labor. This shall be made a condition of each subcontract entered pursuant to the contract.

Regulatory Requirements

1. Applicable Codes: The Contractor shall comply with all State rules, ordinances and regulations relating to elevators, buildings, employment, the preservation of public health and safety, and so forth.

2. Flammable Liquids: Any flammable materials used or installed shall meet all local requirements and be in strict conformance with the current Michigan State Police, Fire Marshall Division, and flammable liquid regulations. The Contractor is responsible for the safe storage of any flammable

materials left onsite, this includes but is not limited to any lubrications and paint.

Contract Execution

The Contractor must sign and date the Contract by the estimated Contract Start Date and provide a current certificate of liability insurance with the required coverage and limits of liability.

Key Personnel

The Contractor must appoint at least one (1) individual who will be directly responsible for the day-to-day operations of the Contract ("Key Personnel"). Key Personnel must be specifically assigned to the State account, be knowledgeable on the contractual requirements, and respond to State inquiries within 3 business days.

The Contractor may not remove or assign Key Personnel without the prior consent of the State. Prior consent is not required for reassignment for reasons beyond the Contractor's control, including illness, disability, death, leave of absence, personal emergency circumstances, resignation, or termination for cause. The State may request a résumé and conduct an interview before approving a change. The State may require a 30-calendar day training period for replacement personnel.

The bidder must identify the Key Personnel, indicate where they will be physically located, describe the functions they will perform, and provide current chronological résumés.

Customer Service Toll-Free Number

The Contractor must specify its toll-free number for the State to contact the Contractor Representative who must be available for calls during the hours of 8 a.m. to 5 p.m. EST Monday through Friday, at a minimum. Identify customer service availability for this proposal by hours and days of the week.

Technical Support, Repairs and Maintenance

The Contractor must specify its toll-free number for the State to contact the Contractor for technical support, repairs and maintenance. The Contractor must be available for calls and service during the hours of 8 a.m. to 5 p.m. EST Monday through Friday at a minimum. Identify availability for this proposal by hours and days of the week.

Security

The Contractor will be subject the following security procedures:

LOG OF PROJECT

US-41/M-26
CS 31012
MAINTENANCE PROJECT

The resulting Contract will require frequent on-site services to a MDOT facility. Security shall include, but is not limited to, use of uniforms and ID badges, etc. If security background checks are performed on staff, the low bidder shall indicate the name of the company that performs the check as well as provide a document stating that each employee has satisfactorily completed a security check and is suitable for assignment to State facilities. Upon request by the State, bidders shall provide the results of all security background checks. Access keys may be issued to the Contractor, if issued, the Contractor will have to sign for the key and return the key at the conclusion of the contract term. Failure to return the key will result in the Contractor being billed to rekey all locks at the Portage Lake Lift Bridge.

The Contractor must explain any additional security measures in place to ensure the security of State facilities.

The Contractor's staff may be required to make deliveries to or enter State facilities. The State may require the Contractor's personnel to wear State issued identification badges.

Hazardous Chemical Identification

In accordance with the federal Emergency Planning and Community Right-to-Know Act, 42 USC 11001, *et seq.*, as amended, the Contractor must provide a Material Safety Data Sheet listing any hazardous chemicals as defined in 40 CFR §370.2, to be delivered. Each hazardous chemical must be properly identified, including any applicable identification number, such as a National Stock Number or Special Item Number.

The Contractor must identify any hazardous chemicals that will be provided under any resulting contract.

Mercury Content

Pursuant to MCL 18.1261d, mercury-free products must be procured when possible. The Contractor must explain if it intends to provide products containing mercury, the amount or concentration of mercury, and whether cost competitive alternatives exist. If a cost competitive alternative does exist, the Contractor must provide justification as to why the particular product is essential. All products containing mercury must be labeled as containing mercury.

Brominated Flame Retardants

The State prefers to purchase products that do not contain brominated flame retardants (BFRs) whenever possible. The Contractor must disclose whether the products contain BFRs. Contractor must describe how products that meet these requirements are identified or otherwise labelled.

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

The Contractor must confirm that the provided products do not intentionally contain PFAS. This consists of all components of the provided products, including product packaging.

OR

The Contractor must disclose whether a product or its components contain intentionally added PFAS. If the product or its components contain intentionally added PFAS the Contractor must:

a. provide an explanation with respect to the intentionally added PFAS contents, including the purpose for which PFAS are used in the product or its components, the types of PFAS used in the product or its components, and the amount of each PFAS used in the product or its components.

b. indicate whether the product will be labeled or packaged with information about the intentionally added PFAS contents.

c. identify any alternative products that do not contain intentionally added PFAS.

d. provide any additional information that would further the Department's implementation of ED 2021-08.

Invoice and Payment

All invoices must be submitted to Ken Filpus at filpusk@michigan.gov and must include: (a) date; (b) quantity; (c) description of the Contract Activities; (d) unit price; (e) parts costs (if any); (f) vendor-generated invoice number; and (g) total price.

Operation Manual

Industrial Rack and Pinion Elevator

MODEL: Trac-Cab TC1200

Portage Lake Houghton Lift Bridge Elevators, Houghton, MI



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 ensure safe use of the equipment, including maintaining current documentation.

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SECTION 1: GENERAL INFORMATION

1.1 INTRODUCTION

The TESI Trac-Cab is a Rack and Pinion Industrial Elevator designed and engineered for industrial applications in harsh environments. The Code classification for the TC3800 system is a permanently installed “Special Purpose Personnel” (SPP) elevator as defined by Section 5.7 of the A17.1 Elevator Code. This machine is to be used by Trained and Authorized Personnel only.

The machine travels up and down the elevator hoistway using single pinion gear drives with single safety, driven by a variable speed electric drive system. The single pinion has a fully redundant integral automatic fail-safe brake system for maximum safety. The 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, Siemens “Variable Frequency Drive” (VFD) speed controller and Rossi Gearmotor with continuous duty integral Fail-Safe drive brakes. The Active Drive System is autonomously backed up by an independently actuated, mechanically set, 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 ETL 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 ET200SP 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 with the use of a key and also may be directed to any floor from the cab-based operator station with the use of a key. Elevator speed and position logic are accomplished via a highly accurate absolute 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, even after a power failure. 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 bypass-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.

1.2 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 ensure 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.**

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

1.3 WARRANTY

Warranty Program

TESI warrants all components to be free of defects in material and workmanship for a period of (12) months from the date of initial installation, provided a dated Final Inspection and Testing Report proof of proper installation by a TESI authorized representative, and / or State Inspection Certificate is provided.

Warranty Conditions

This warranty does not apply to products that have been abused, misused, or modified. Normal wear and tear are 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.

1.4 ABOUT TESI

TESI is a small business and USA based manufacturer that specializes in custom engineered, advanced, permanently installed rack and pinion elevator systems. This structure allows us to be nimbler with design and offer unique solutions you will not find elsewhere. We embrace and implement technology solutions for maximum safety and usability in all of our Elevator and VRC systems.

We are 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.

TESI was founded to bring improvement and innovation to this very specialized market niche. The founder and CEO of our company, Jim Tiner has been involved with industrial construction, service and manufacturing for over 35 years. Our history and background working with tall tower construction and engineering, up to 2,000ft above the ground, has given us the skills necessary to manage our elevator activities with confidence.

TESI has a strong history with custom designed and engineered permanently installed rack and pinion elevator projects. The TESI Trac-Cab elevators can be custom designed specifically for any application with important features that you will not find from any of the other vendors. For instance, TESI provided the new Rescue Elevator in the Statue of Liberty in 2012.

TESI equipment is made in the USA, using American Steel, and supports the “Buy America Act” by creating and sustaining US manufacturing jobs. This is an important objective under the US Governments’ Rebuild America plan.

Since entering the Industrial Rack and Pinion Elevator marketplace TESI has been accepted by industry, and has been the successful bidder in competitive situations to the Federal Government, multiple branches of the military, Black & Veatch, Audubon Bridge Constructors, Chicago Bridge and Iron, CEMEX and other large organizations.

SECTION 2: SYSTEM OVERVIEW

2.1 JOB DETAIL

Customer	Zenith Tech / MDoT
Application	Bridge
Location	Portage Lake Bridge, Houghton, MI
TESI Model Number	Trac-Cab TC1200 R&P Elevator
TESI Job Number	23-0119-1
Customer JOB / PO Num	504931 / 41361
Environment:	Outdoors
Electrical Classification	Not Classified
Code Design Reference	ASME A17.1-2016
Elevator Classification	Permanent Installation Rack and Pinion Elevator per Section 4.1 of ASME A17.1 / CSA B44
Personnel Loading	Class CA Loading
Drive System	Rack & Pinion Drive System with Severe Duty Option

2.1.1 Elevator System Configuration

Capacity (Rated Load)	1200 lbs.
Cab Size	Passenger cab with (1) Cab Gate. Approx 3' deep x 3' wide x 7'-6” high
Cab Configuration	Single Cab Collapsible Gate 304SS Diamond Plate Steel Floor & Kickplate, 316SS Panel Walls.
Cab Interlock Type	TESI – Fortress Electric Interlock Safety Switch w/ guard locking, closed & lock monitoring
Speed	100 Feet per Minute (Nominal)
Height	164’-0” feet of Travel (Nominal) Tower Height 170’-0”
Landings	North – 3 Landings South – 4 Landings
Landing Door Type	By Others
Landing Interlock Type	TESI – Fortress Electric Interlock Safety Switch with guard locking, closed & lock monitoring
Power	Motor Horsepower – SEW 20HP – DRN160L Worm Gearbox –Rossi – MR V 160 UO2A – 42X350 - 25
Gear Ratio	25:1 Reduction
Pinion	3DP 25 PA 18 Tooth – 6.667" Pitch Diameter – 1.75” Face Width
Gear Rack	3DP 25 PA -1.5” Face Width x 3” Wide Gear Rack

Counterweight	Not Applicable
Elevator Control	TESI UL Classified Elevator Controller - Fully Automatic with Lighted Calls at Landings and in Cab
Speed Control	Variable Frequency Drive
Overspeed Safety	TESI - EIDE - Independent R&P Safeties Per A17.1 Part 4.1.9
Emergency Lower	TESI Hydraulic Full Height Lowering System
Cable Management	Energy Chain
Controls Package	NEMA 4X Stainless Steel Controls Upgrade Automatic Passenger Controls Dual Color Touch Panel User Interface Control Stations Absolute Rotary Encoder Hoistway Access

2.1.2 Electrical Service

Electrical Service 480 VAC 3P 60 Hz:	60 Amps at 480 Volts, 3 Phase, 60 Hz Provides Main System Power for Elevator
Electrical Service – Car 120 VAC 1P 60 Hz: 15 Amp	15 Amps at 120 Volts, 1 Phase, 60 Hz NEC Code Required Separate Circuit with Lockable Disconnect to Feed Cab Lights, Fan, Utility Outlet
Electrical Service – Pit 120 VAC 1P 60 Hz: 15 Amp	15 Amps at 120 Volts, 1 Phase, 60 Hz NEC Code Required Separate Circuit with Lockable Disconnect to Feed Elevator Pit Light and Receptacle
Telco Service: Emergency Communications	Cellular Gateway to PSTN Analog Telephone Line

2.2 SYSTEM OVERVIEW – BRIDGE ELEVATOR

2.2.1 Normal Operating Parameters

Max Cargo Load: 1200 lbs.
Nominal Speed During Automatic Operation: 100 fpm
Operation: Fully Automatic



2.4 TRAC-CAB MAIN COMPONENTS

2.4.1 Elevator Controller

Designation: CP1

Location: Mounted on Pit Foundation behind Rail Section

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.



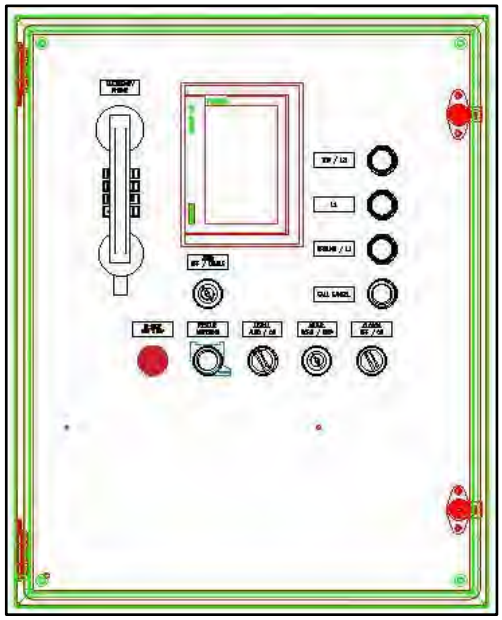


2.4.2 Car Operating Panel

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.

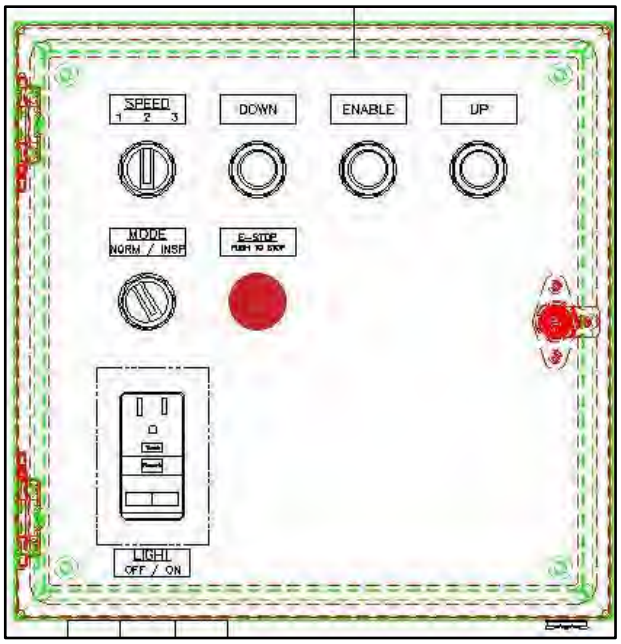


2.4.3 PD1/Car Top Control Panel

Designation: Car Top Control (CTC)

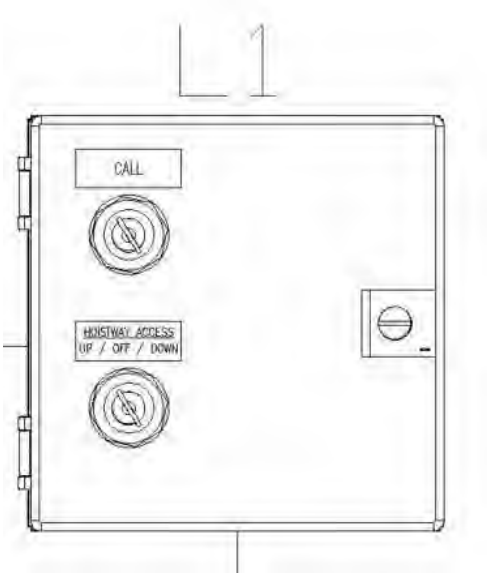
Location: Mounted at the Car Top in Enclosure

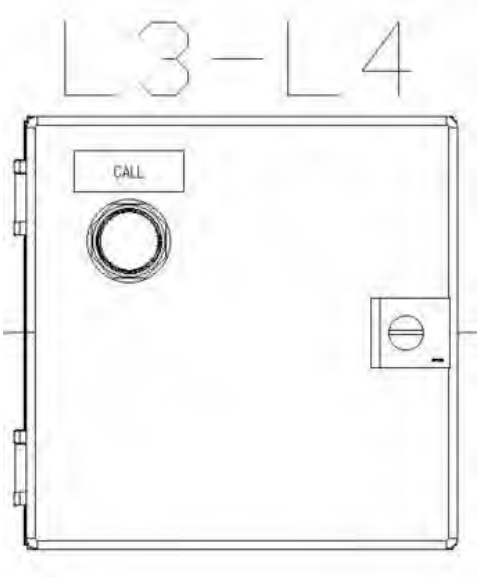
Function: Provides Code Required Car Top Inspection Control



2.4.4 Floor Call Stations

Designation: CS1
Location: Mounted near the Landing Doors at Ground Level and Shelter Level
Function: Call stations are provided for automatic elevator operation for authorized personnel only. To call the elevator user will have to be in possession of an authorization key. The key will need to be inserted into the ACCESS selector switch and switched to the ENABLE position. Using the same key, remove it from the ACCESS selector switch and insert it into the CALL selector switch. Turn the key to the right momentarily to CALL the elevator.





2.4.5 Landing Door

Designation: Landing Doors

Location: Ground and Shelter Landing Levels

Function: Landing doors will be manually operated, Interlocked Elevator Landings doors. 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 inside the hoistway (for emergency egress) 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.

Landing
For Hoistwa



de Emergency
g Door Interlock.



2.4.6 Cab Door

Designation: Collapsable 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.



2.4.7 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.



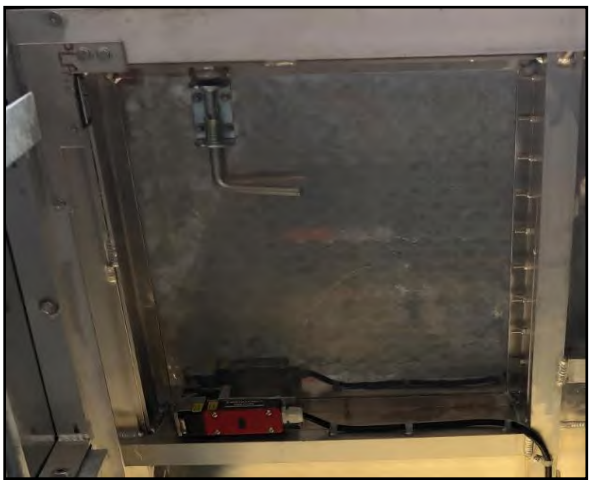


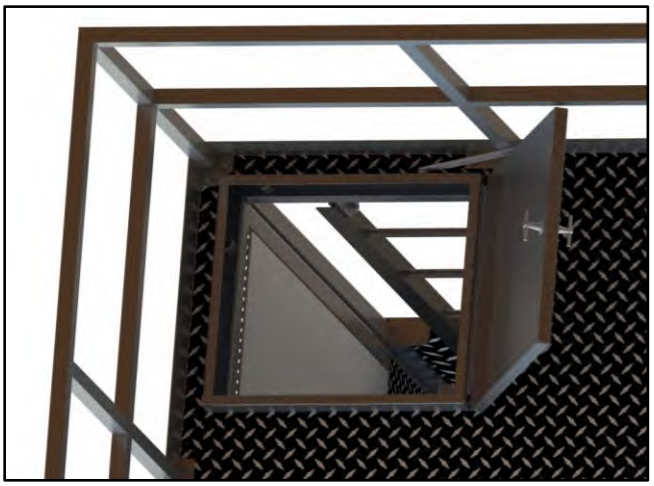
2.4.8 Maintenance and Emergency Exit Hatch

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.





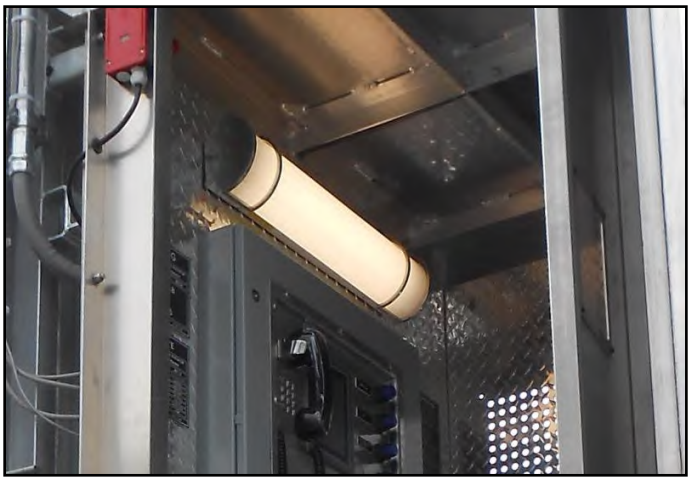
2.4.9 Interior Car Light

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.

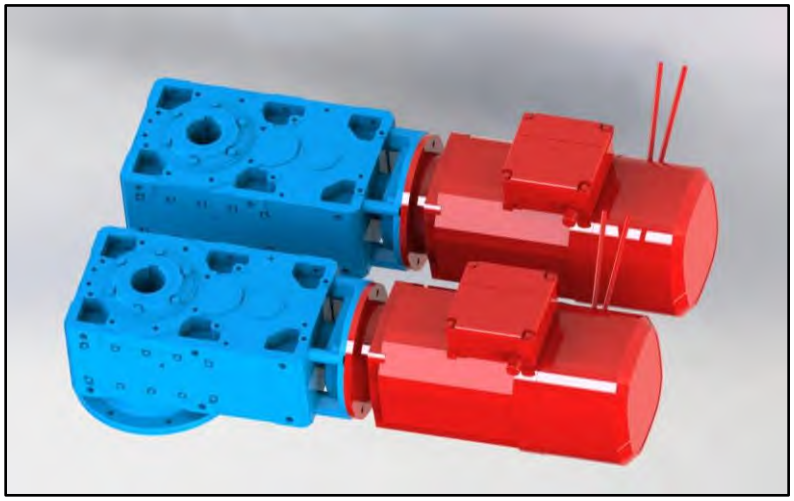


2.4.10 Drive System

Designation: Drive System

Location: Mounted to the tractor plate on top of the cab

Function: A variable speed electrically powered drive train that transfers electrical power to mechanical movement via the gearmotor and pinion drive gear. The pinion gear is positively connected to the rack providing the elevator lift.



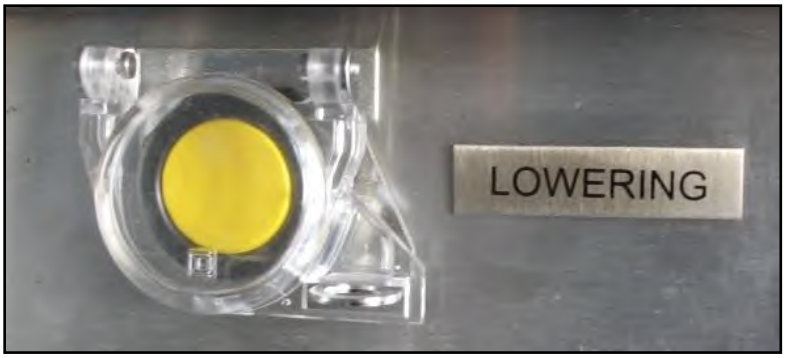
2.4.11 Hydraulic Emergency Rescue Lowering System

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.





2.4.12 EIDE Overspeed Safety Brake

Designation: Automatic Centrifugal Brake

Location: Mounted above the Cab under the electric motor.

Function: In the event of an Over Speed condition, the Safety Brake will engage to mechanically slow and stop the car independently.

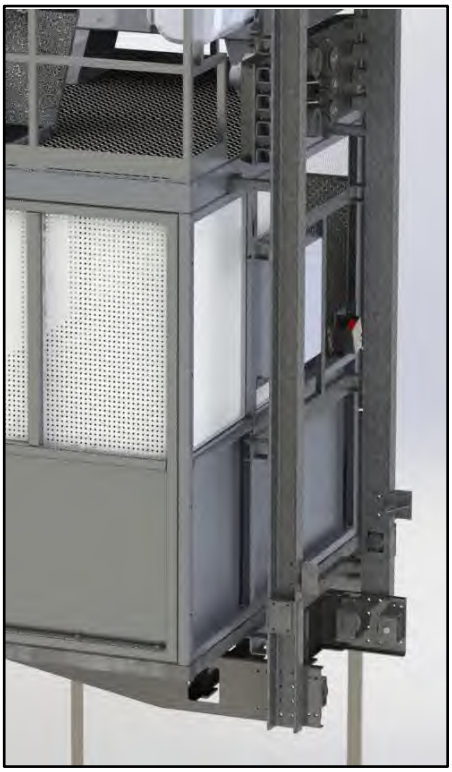


2.4.13 Tractor Backbone

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.



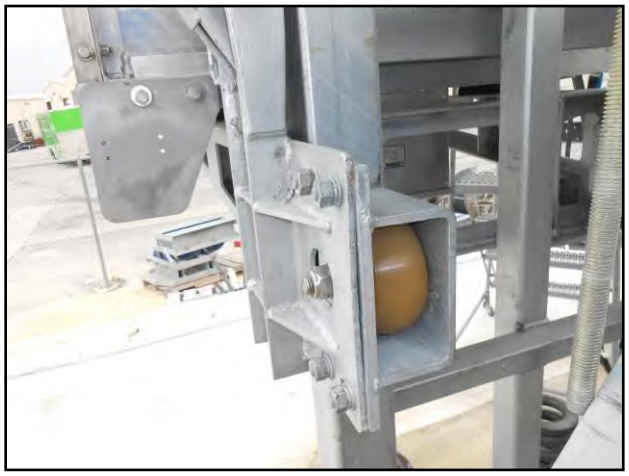
2.4.14 Elevator Guide Wheels

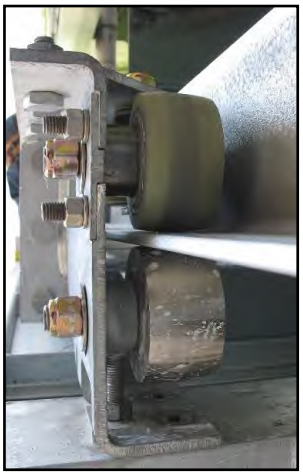
Designation: Guide Wheels & Axles

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 precision sealed ball bearings that require no lubrication. Alignment & Backing wheels are Poly Tread over Aluminum Hub with double stacked precision sealed ball bearings that require no lubrication.





2.4.15 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.



2.4.16 Spring Buffer Assembly

Designation: Spring Buffer

Location: Mounted in the Elevator Pit

Function: The spring buffer assembly provides shock absorption in accordance with ASME A17.1 should the car impact in the pit.



2.4.17 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.



2.4.18 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.

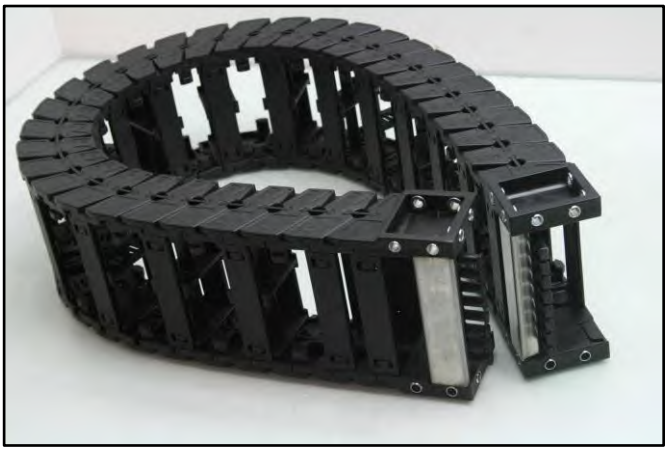


2.4.19 Energy Chain for Managing Power, Control and Communications Cable

Designation: Energy Chain Cable & Carrier

Location: Mounted to Hoistway

Function: Provides a means for guiding and protecting the moving Power, Control and Communications cable that is linked between the CP1 cabinet and the traveling car.



2.4.20 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 run by area in the Hoistway. Switches are mounted to the tractor plate and "CAMs" are mounted to the rail system in the hoistway above the shelter landing and below the ground landing. Upon actuation the car can be driven off the switch in the opposite direction of travel using Inspection Control.





2.4.21 Main Power Disconnect

Designation: Disconnect

Location: Mounted on Pit Foundation behind Rail Section

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.

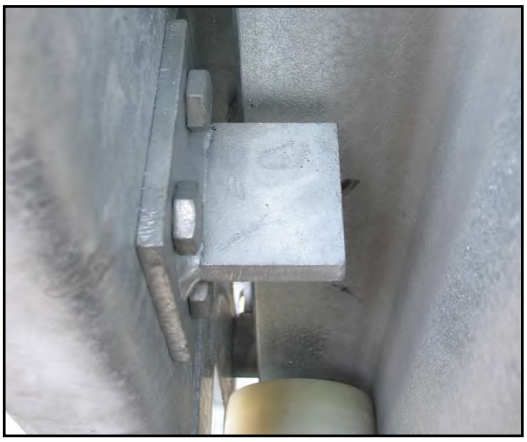


2.4.22 Rack and Pinion Safety Hooks

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.



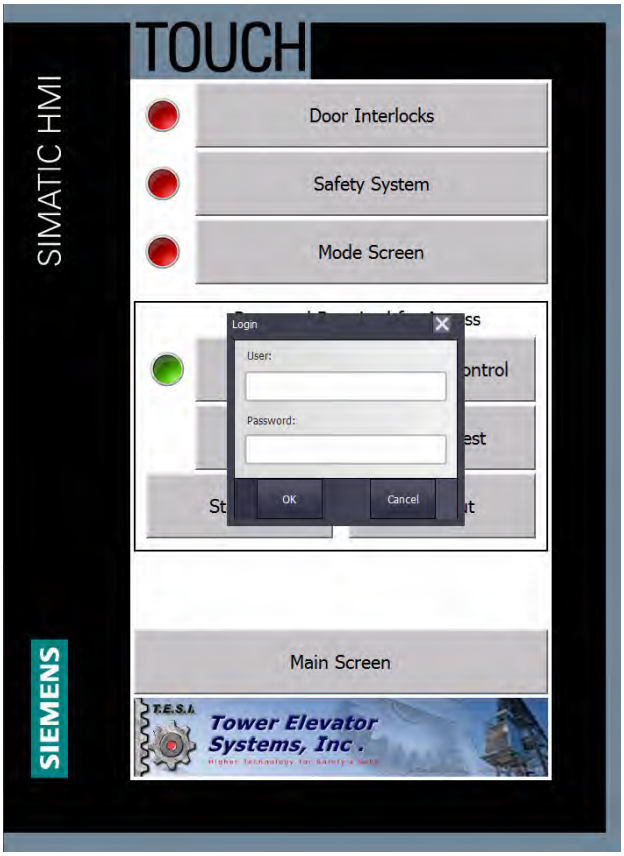


SECTION 3: STARTUP AND COMMISSIONING

3.1 START-UP AND COMMISSIONING SCREEN

3.1.1 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 & Password, 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.

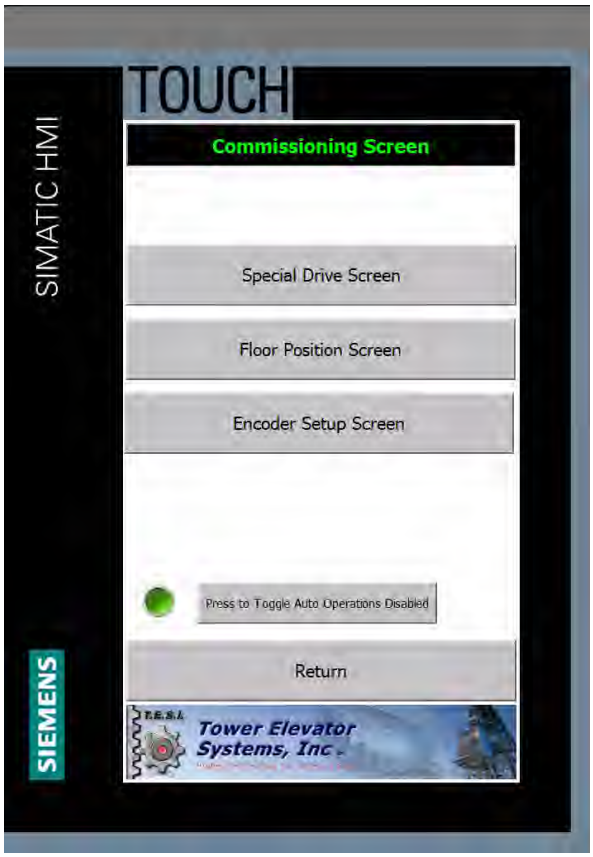


Start-up and Commissioning: User "_____" Password "_____"
Used to Set Initial System Parameters

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.

3.1.2 Commissioning Screens

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.

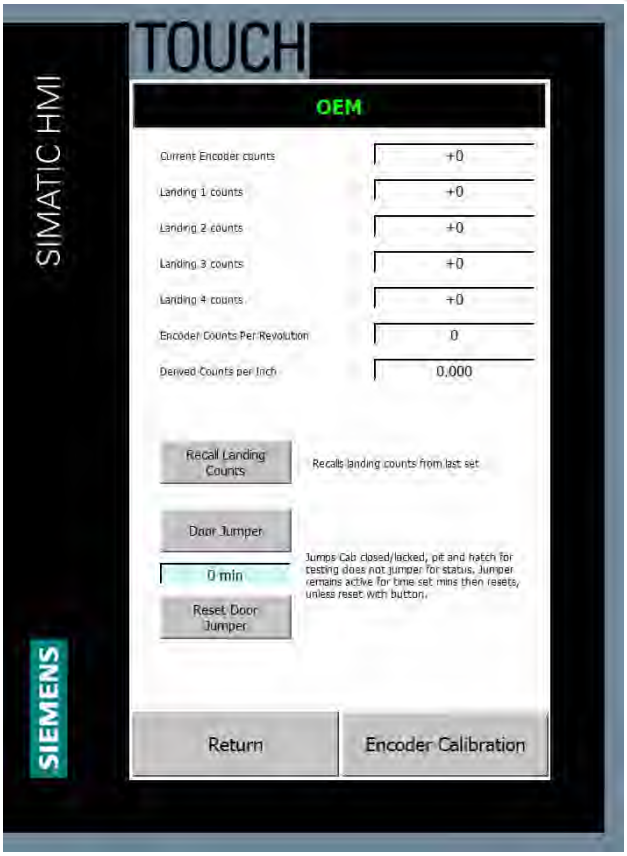




3.1.3 Encoder Setup Screen

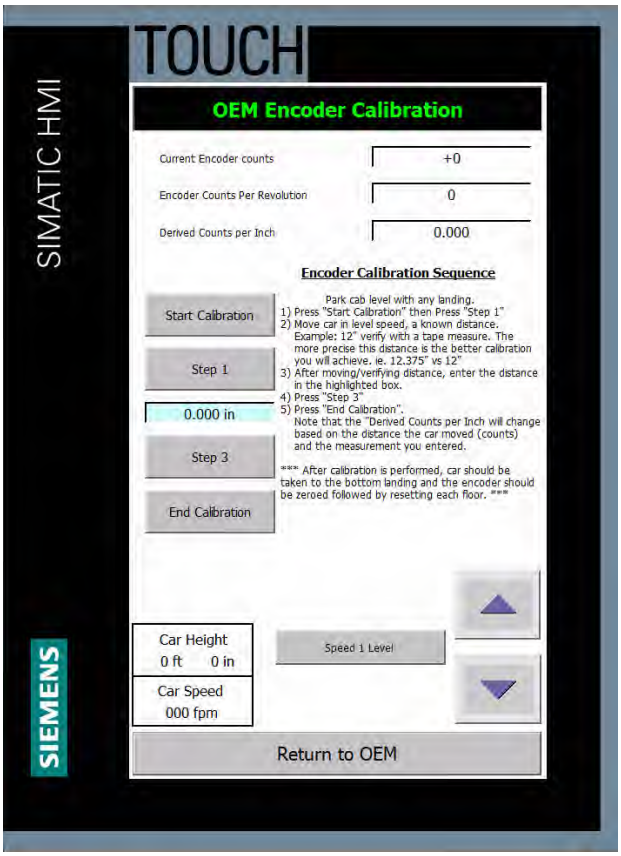
Allows qualified personnel to view & edit the merge distances as the elevator cab comes into a landing. The merge & buffer distances make up the distance that the elevator will start to slow down when approaching a landing that it is traveling to. The overshoot fields allow fine tune adjustments of how close the elevator stops at a given landing.

3.1.4 OEM Screen



***The following OEM screens require a separate user/password. ***

Allows qualified personnel to recall previous landing settings in case there was an encoder issue. Also shows the current counts on the encoder. During commissioning, this screen can also be used to jumper out doors for a given period of time.



3.1.5 Encoder Calibration Screen

Allows qualified personnel to calibrate the encoder upon first commissioning and/or replacement of the encoder. By following the onscreen instructions and using a tape measure, the elevator will self-calculate counts per inch factor. This is required so that the foot/inch measurements for elevation will be accurate.

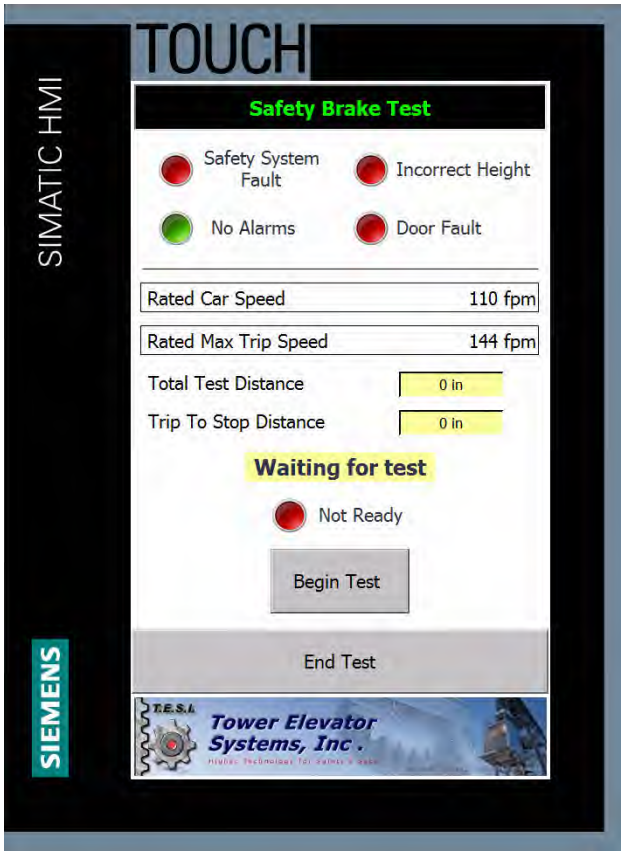
3.2 SAFETY BRAKE TEST

Per the Code requirement, the system has been programmed to allow testing of the Safety. This is accomplished via the Control Room station Touch Panel administration screen "Brake Test". The test is initiated remotely from the 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.

3.2.1 Brake Test Screen

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.



3.2.2 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 centrifugal force brake will engage 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 Overspeed fault has occurred, an authorized technician must acknowledge the fault and reset the "Overspeed Alarm" to return the system to normal operation. Once the Alarm Condition is reset, the safety brake reset procedure below must be performed.

Upon Brake Test Initiation, the Elevator motor brakes will be released, initiating a free-fall, until the Cab reaches the overspeed threshold, at which time the centrifugal force brake will engage.

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.

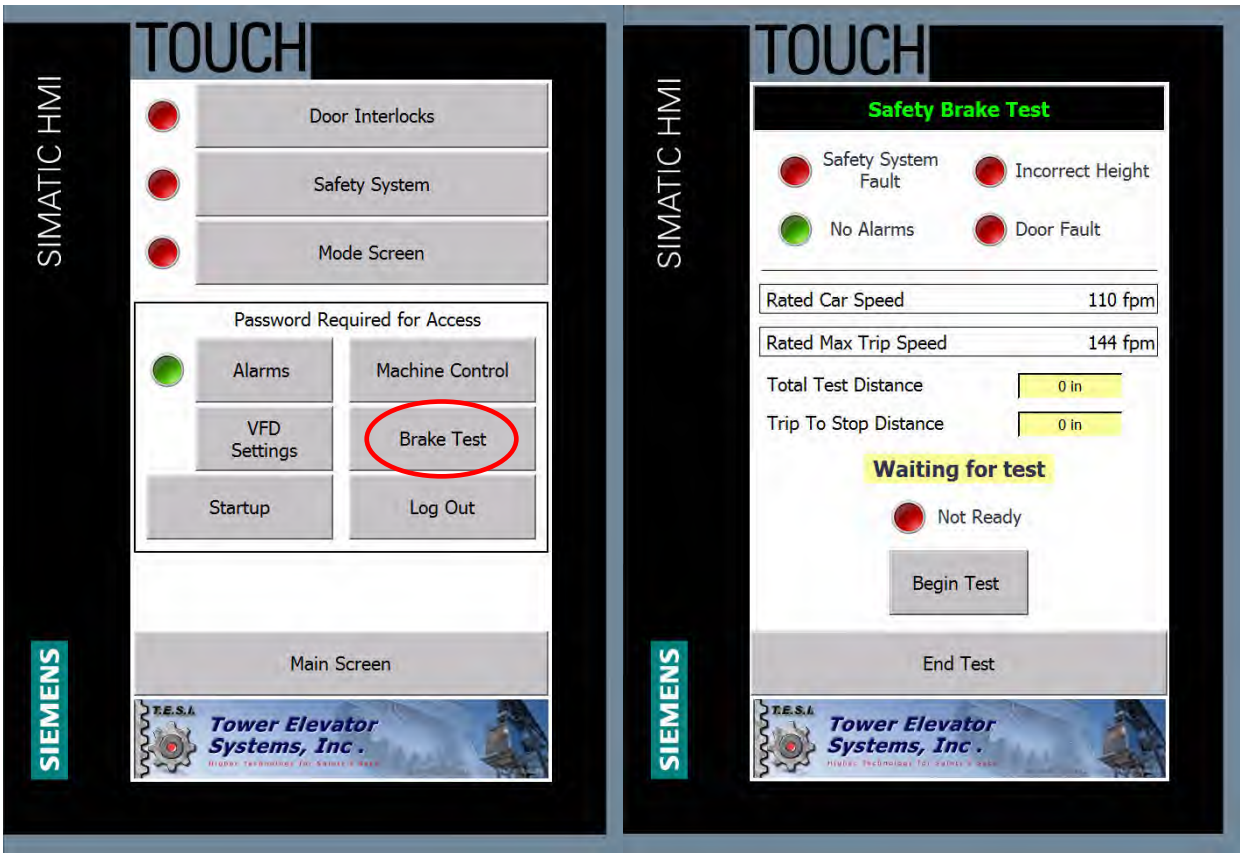
SAFETY NOTE: *This operation initiates a forced elevator free fall, by bypassing several internal safety system safeguards, and directly releasing the drive brakes with no drive run command active. No person should be in or under the cab during testing. The test can only be administered from the CP1 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.*

3.2.3 Testing the Centrifugal Force Brake Step by Step Instructions

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

1. Make sure all doors are closed and elevator is "ready"
2. A technician with "Brake Test" access must "log in" at the CP1 Control Room 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. Test Results can be viewed by pressing the “View Results” button.
8. Reset the safety brake following the procedure listed in the “Safety Brake Reset Procedure” section.



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.

3.2.4 Safety Brake Reset Procedure

Once the Safety Brake has been engaged, the following step-by-step procedure must be performed before the elevator is allowed back in service.

1. Determine if the car is safe to move.

2. Using machine control or inspection mode, drive the elevator car up to disengage the brake.

3. Safety Brake is now ready, and no further action is needed. There should not be any unauthorized tampering or removal of the Safety Brake. Safety Brake has been factory calibrated and TESI will not be liable for any alterations that will void the warranty.

Code Ref: A17.1 / 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.

Once the Alarm Condition is reset the Elevator can be taken in Special Drives Mode to the landing to re-initialize automatic operation and return the machine to service.

SECTION 4: NORMAL ELEVATOR OPERATION

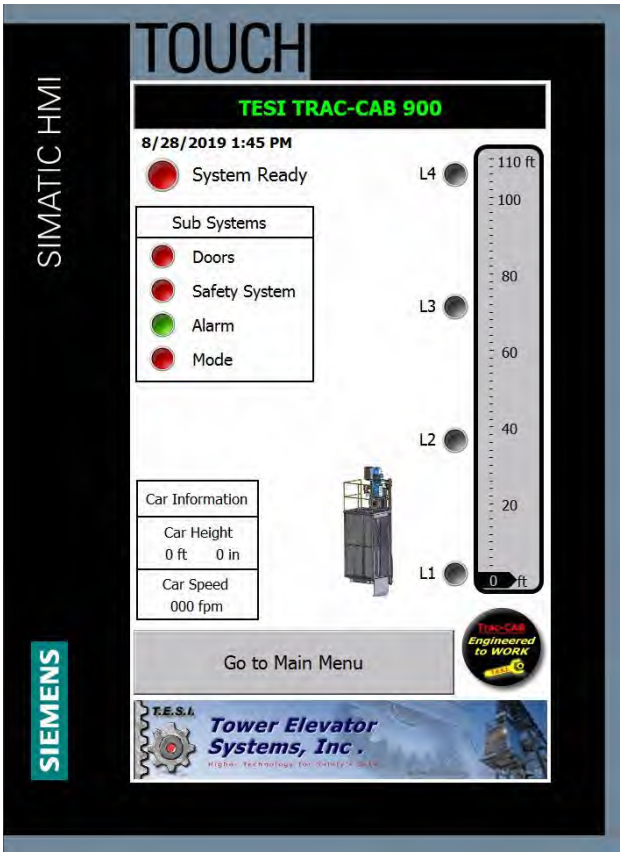
4.1 OPERATION POLICIES

Only properly trained and authorized persons are allowed to operate this equipment. Normal and Emergency Operation training must be completed and documented prior to use of this equipment.

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

4.2 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 switch in Cab.*
- **Cab Inspection Mode:** *Manual Car Control, for trained and authorized technicians only, accessed with a from the Car Operation Panel and key code from the administration menu operated from the cab touch panel*
- **Control Room CP1 Administration Mode:** *For trained and authorized technicians only, accessed via key code from the administration menu and operated from the ground position touch panel*



4.3 AUTOMATIC OPERATION

In normal automatic mode the elevator control is via fully 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 fully 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.

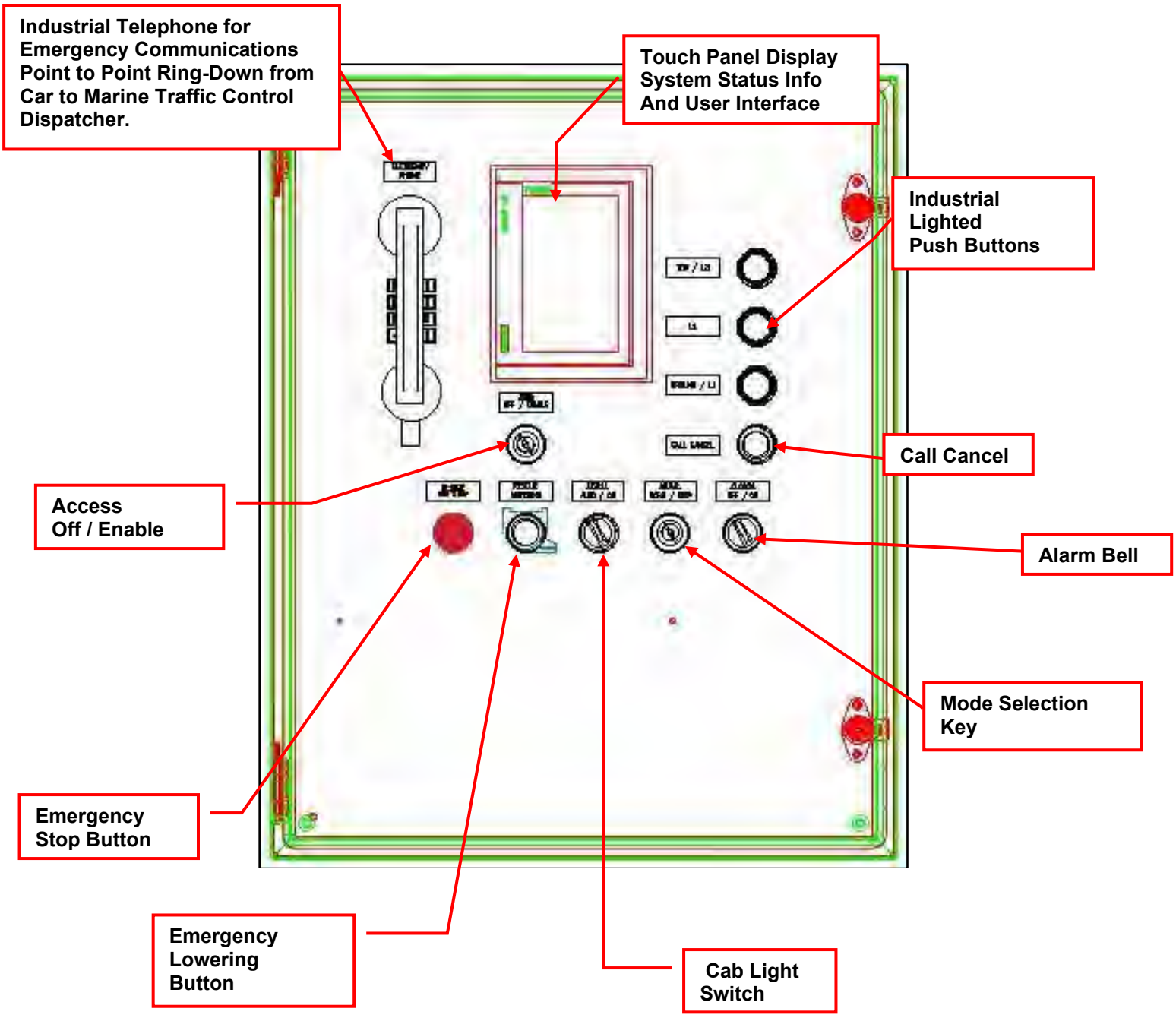
4.3.1 NORMAL OPERATION MODE

Elevator Ready / Automatic Operation

- Verify the electrical power is ON to the Main Controller.
- To call the elevator from parked position to the ground level, users will have to be in possession of an authorization key.
- The key will need to be inserted into the Activate Call selector switch and switched to the on position.
- Using the same key, remove it from the Activate Call selector and insert it into the Call selector switch.
- Turn the key to the right momentarily to call the elevator.
- To access the elevator from the shelter landing you will have to press the call button to unlock the landing door.
- Once landing door interlock disengages, you may enter the elevator.
- Confirm all required inspections have been performed.
- Ensure 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.
- Once the user has reached the desired landing and the car is turned off at the control panel. The car will return after 60 seconds to its parked position at the shelter level.

4.3.2 TYPICAL TRAC-CAB CAR OPERATING STATION LEGEND



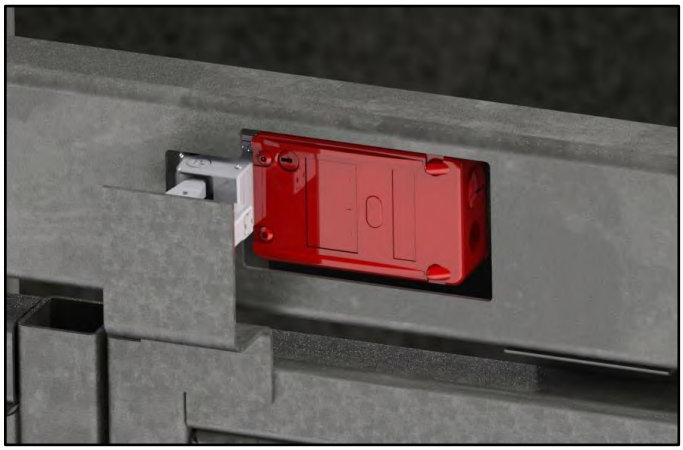
4.3.3 AUTOMATIC OPERATION – LANDING DOOR INTERLOCKS

The Landing Doors are manually operated 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 in the “unlocking zone”. Access to the Elevator will require a physical key for authorized personnel only.

In normal operation, while the car is at the shelter level, the operator should press and hold the “CALL” button while pushing the door to separate the doors and access the landing. When the car is located in the “unlocking zone”, the controller will be signaled to actuate the electric access solenoid lock allowing the door to be pulled open. When the button is released the interlock will close to its “FAIL-SAFE” locked condition. When the Authorization Key is used to call the elevators to the ground level, the doors will unlock when they reach the “unlocking zone”.

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.

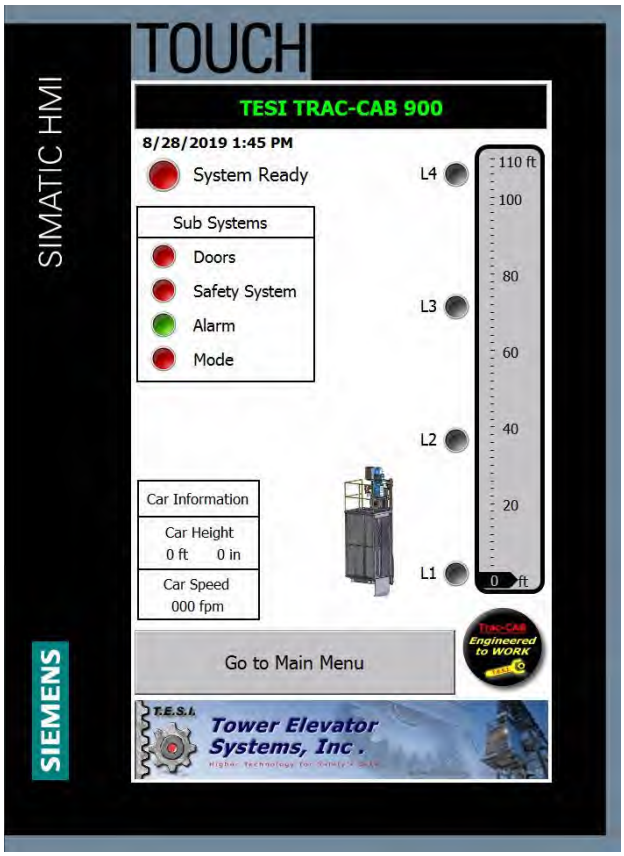




The electric access control interlocks are configured for Fail-Safe operation, meaning they will remain locked until they are provided a signal by the elevator controller. The solenoid lock will not actuate, unless the car is configured for automatic operation and parked at the desired landing. The landing doors will also remain locked in the event of system power failure.

4.3.4 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.



GENERAL LED INDICATORS on HMI

- Green indicates ready
- Red indicates Fault
- Black indicates off

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.

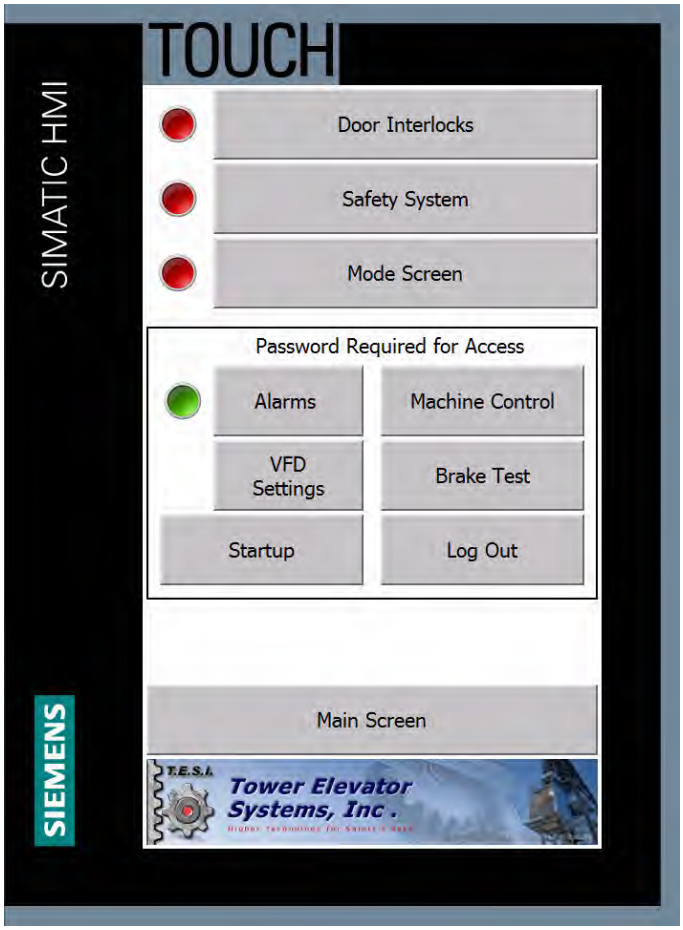
There are system ready lights providing at-a-glance system status. More detail can be found by navigating to the corresponding sub-system detail screen from the Main Menu.

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

4.4 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.



4.4.1 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)

- Cab door Closed / Locked
- Emergency Exit Hatch Switch (if applicable)
- Hoistway Access Door Switch
- Landing doors - Closed / Locked

Safety System:

- Cab E-Stop
- Ground Station E-Stop
- Car Top E-Stop
- Pit E-Stop

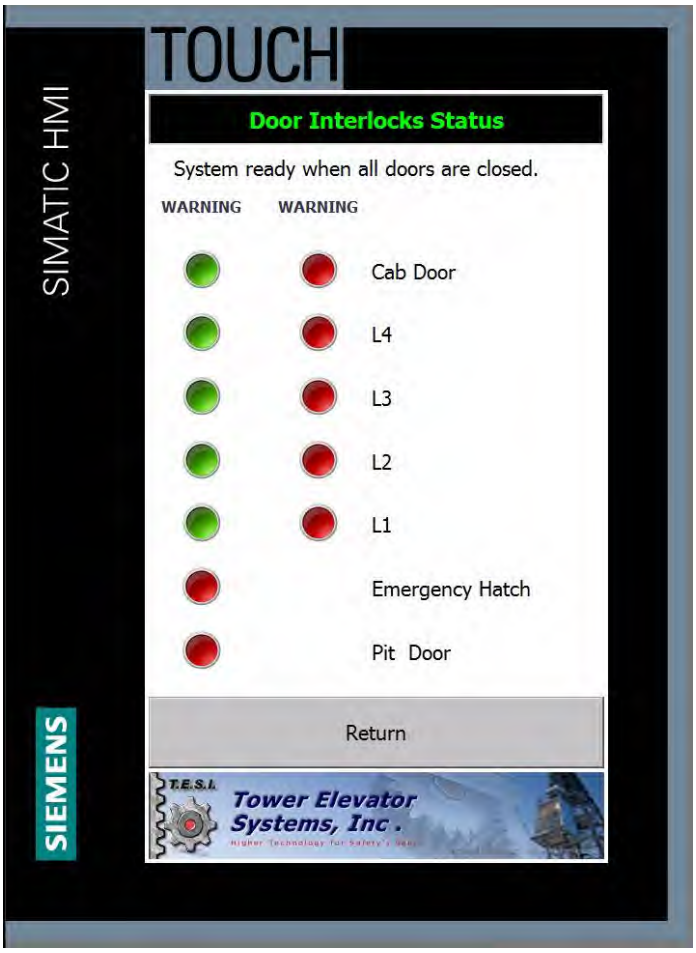
Note: Safety E-Stop Conditions must be acknowledged prior to placing system back in service. Correct Condition and use on-screen reset or "RUN" button to reset system.

Mode Screen:

- Shows position of Mode Key Switch and Status of HMI Machine Control Usage

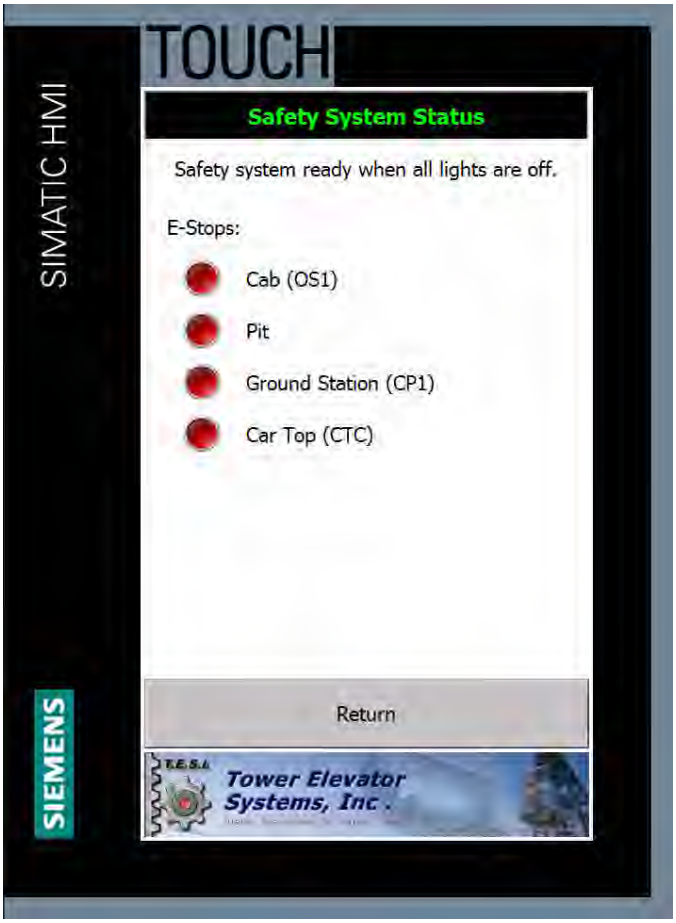
4.4.2 SUB-SYSTEM - DOOR INTERLOCK SCREEN

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



4.4.4 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.

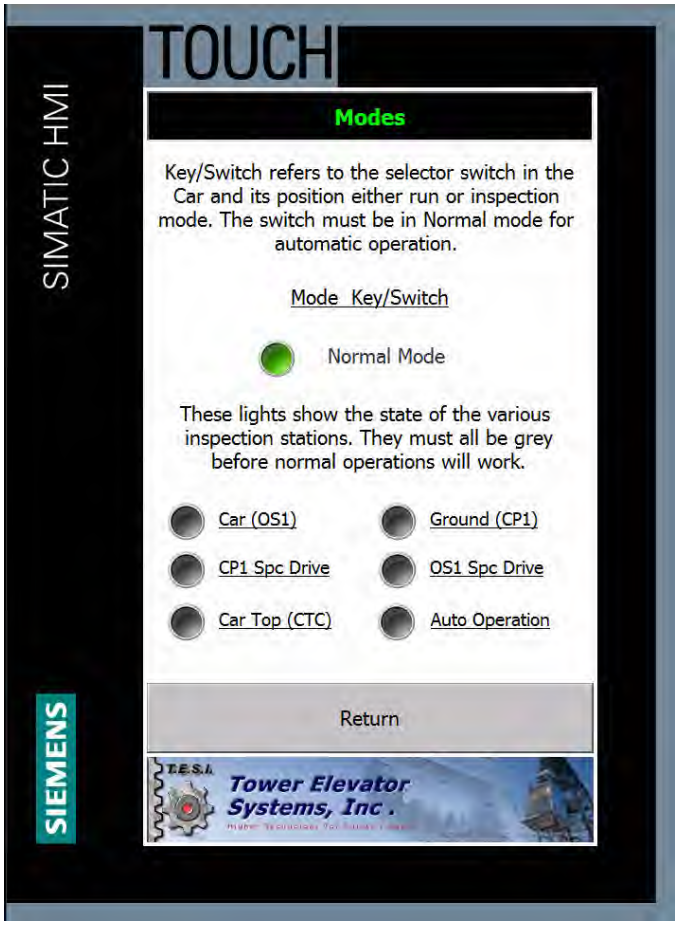


The Trac-Cab is controlled by a Fail-Safe Safety PLC controller. Safety PLC's by design latch and Log all E-Stop Actuations. The system incorporates (4) Safety E-Stop stations: Car Top, Car Operating Panel, Ground Control Station and Pit E-Stop. Pushing any E-Stop will also remove the "Safety System Ready" condition. 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 by pulling it back out to reset the Safety system. All E-Stops must be returned to the "out" position, to re-activate the system. If all conditions have been met, the Safety System Ready light will return.

SECTION 5: MACHINE CONTROL AND INSPECTION MODES

5.1 MODE SCREEN

Shows Condition of Various Mode Switches for System Inspection Operation



5.2 ACCESS TYPES

Start-up and Commissioning:

Used to Set Initial System Parameters
Password Expires 1 hour 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)

- 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.

5.2.1 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 Login information (user & password)
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.

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.

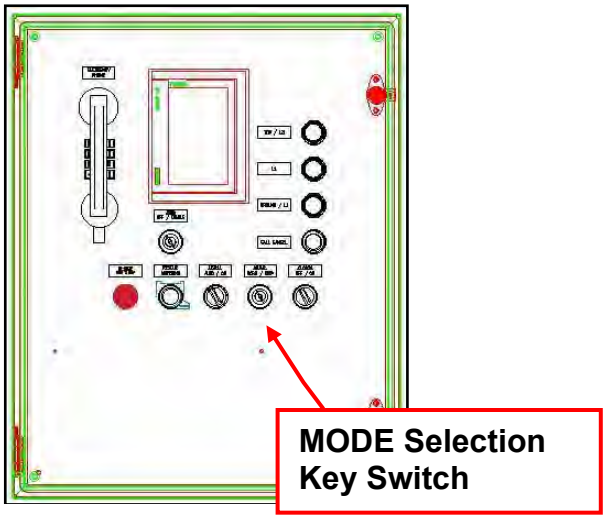
5.3 MODE KEY SWITCH OPERATION: CAB

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

NOTE: System Mode Status can be viewed on MODE SCREEN



Modes are outlined in order of Priority Hierarchy.

2.26.1.4.2 - Car Top Inspection Mode
Over Rides all other 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.

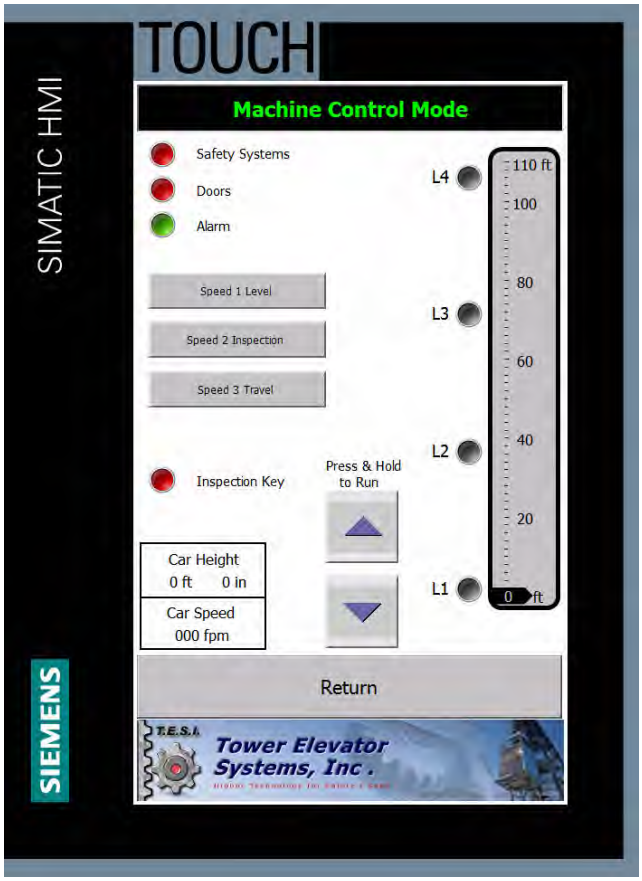
5.4 MACHINE CONTROL: OS1 CAB TECHNICIAN MODE

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.



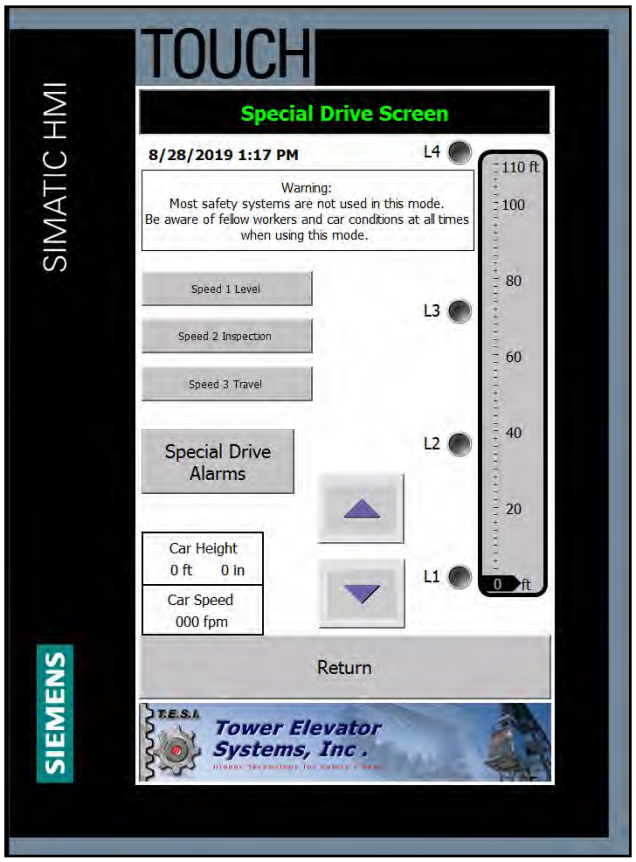
5.5 MACHINE CONTROL - CP1 GROUND STATION

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 touch panel. 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



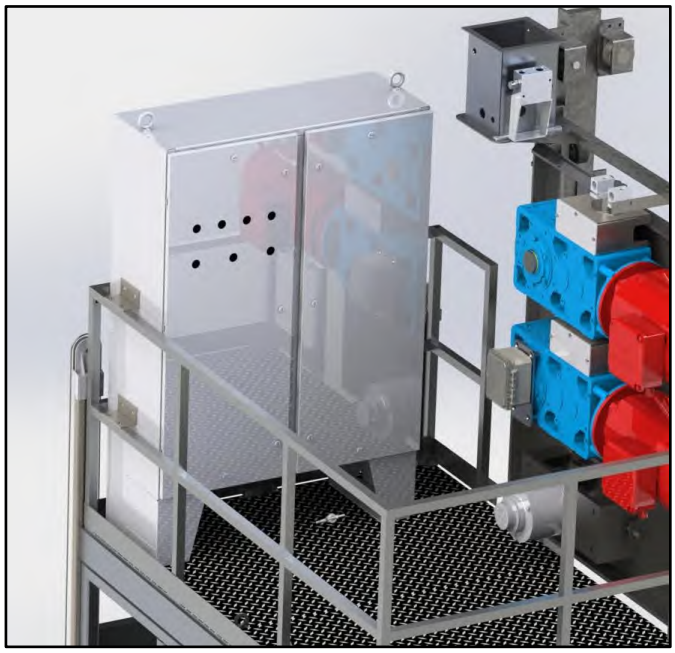
5.6 CAR TOP INSPECTION MODE:

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.

SECTION 6: ALARM & FAULT CONDITIONS / SYSTEM TROUBLE SHOOTING

6.1 OVERVIEW

6.2 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.

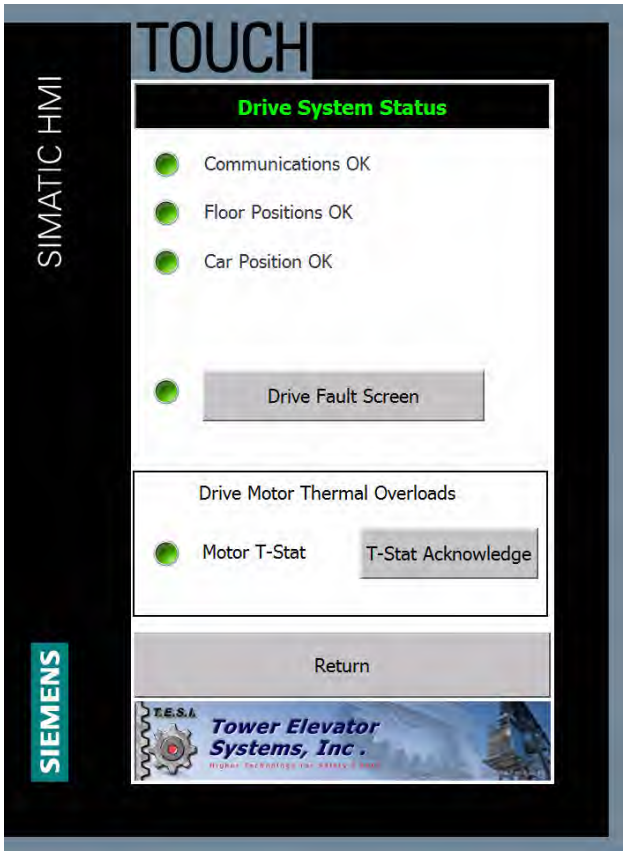
Note: Alarm System Fault Conditions are latched to allow review by a technician. The noted fault condition must be corrected and reset prior to placing system back in service. System Faults must be reset by an authorized technician. Diagnose and Correct Fault, then use on-screen button to reset system.

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.



6.3 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.

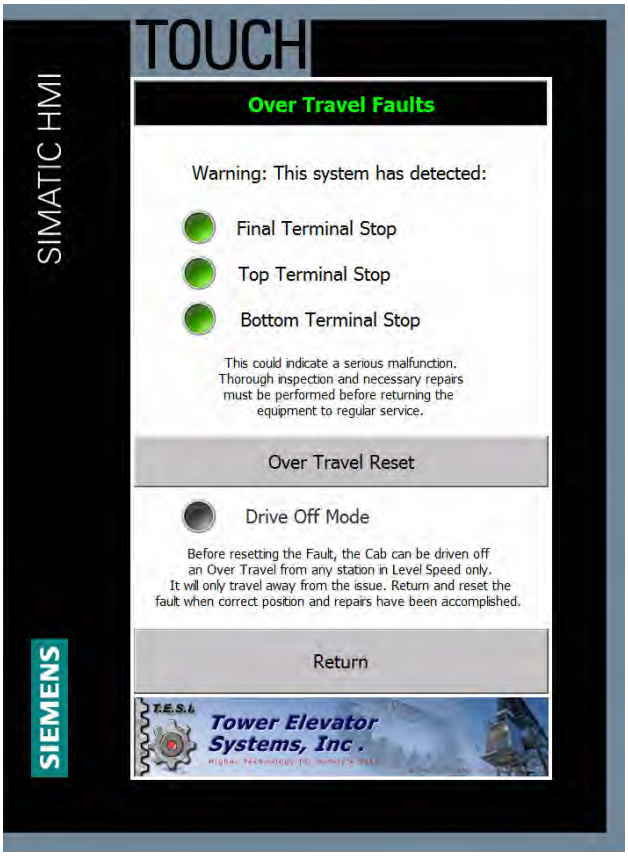


6.4 OVER TRAVEL FAULT

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.

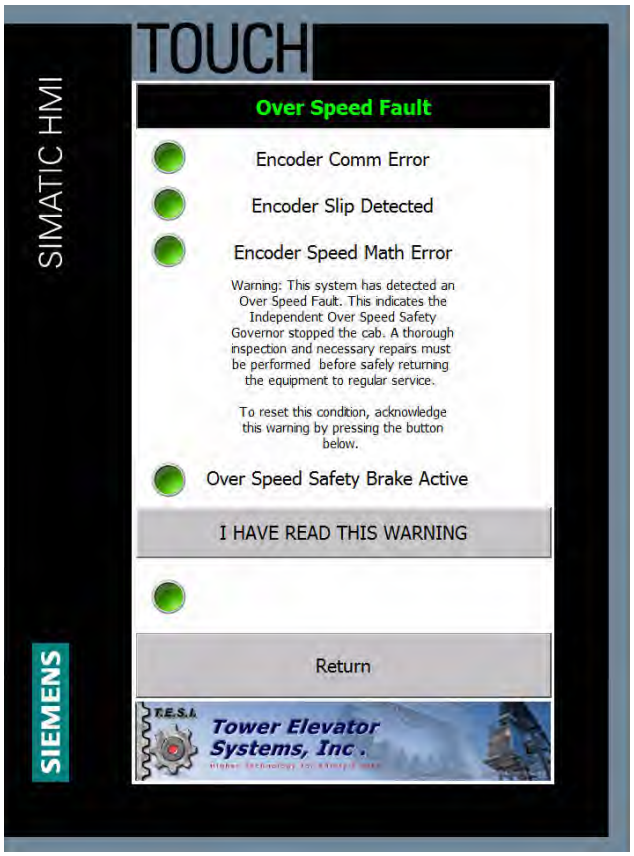


6.5 OVERSPEED FAULT

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 over speed governor in the independent Safety system.

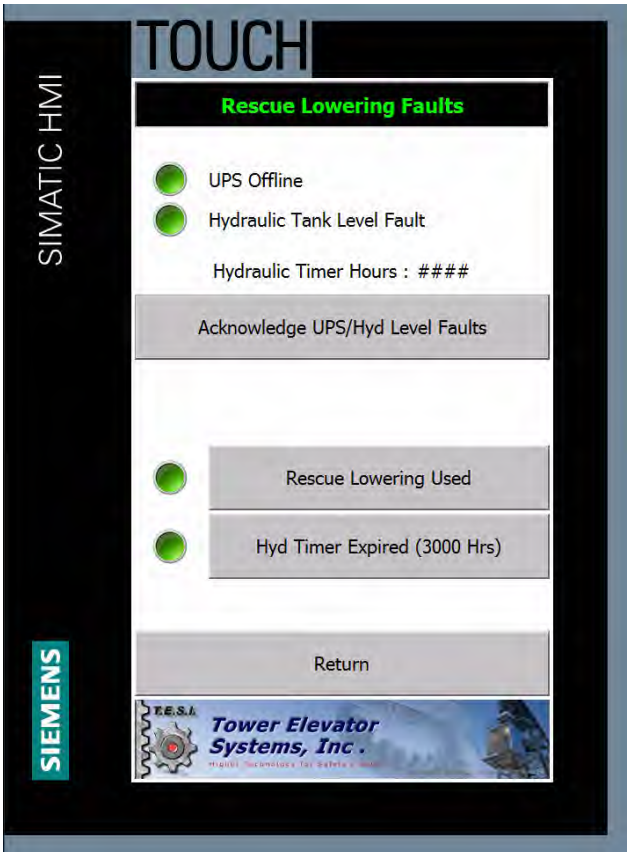
If the Over Speed condition occurs, it should be considered very serious and requires a thorough inspection and necessary repairs be made by an authorized service technician prior to placing the elevator back in service.

The 1st Over Speed Fault screen displays a warning message that must be read and acknowledged before the fault can be cleared.



6.6 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

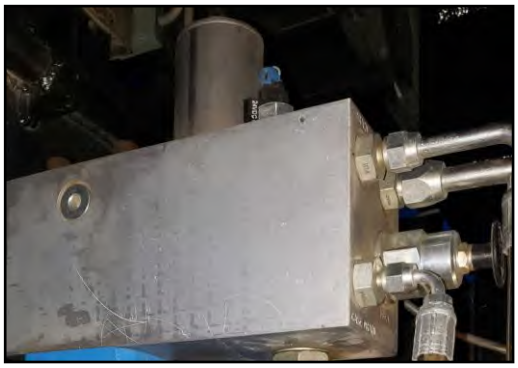


6.6.1 LOWERING FAULT DETAILS:

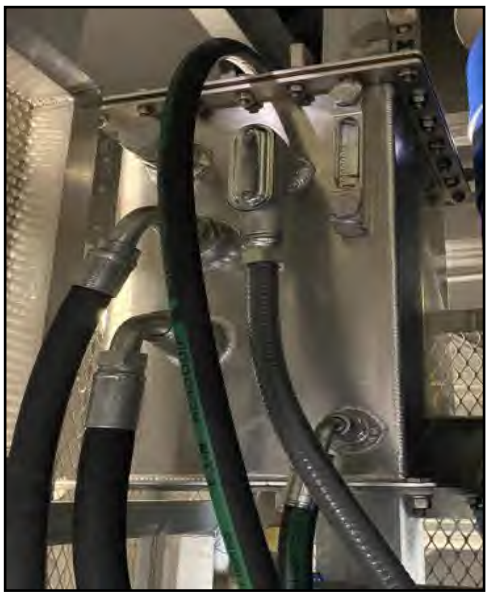
UPS Offline
The system incorporates an onboard UPS (uninterruptible power supply) that provides battery power to release the electric brakes when the button is pushed. This allows operation of the Rescue Lowering System, even if main power is disconnected. The "UPS Offline" fault would indicate there 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. This could indicate a blown fuse, shorted wire or other electrical circuit problem. This condition would prevent the valves from closing in rescue lowering mode.



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.



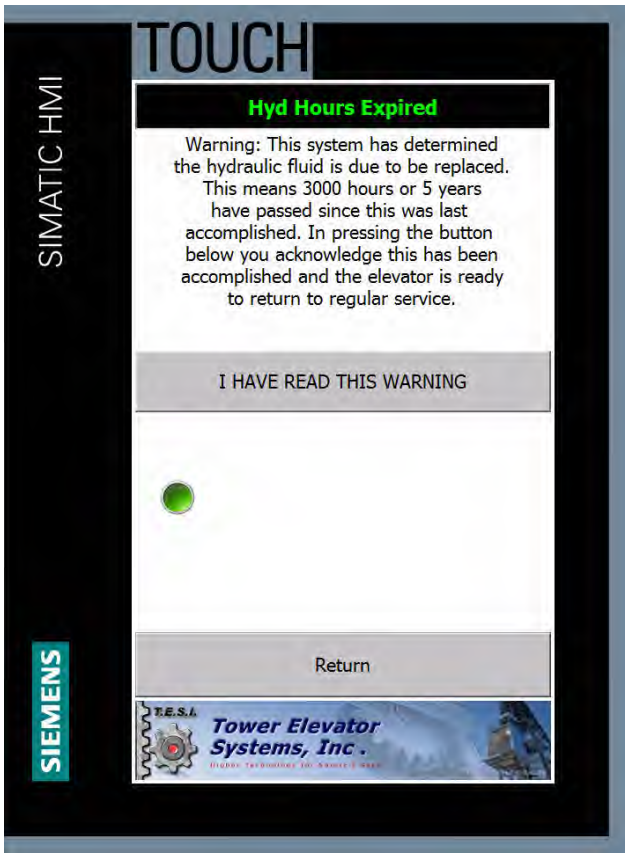
6.6.2 HYDRAULIC TIMER EXPIRED FAULT

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.

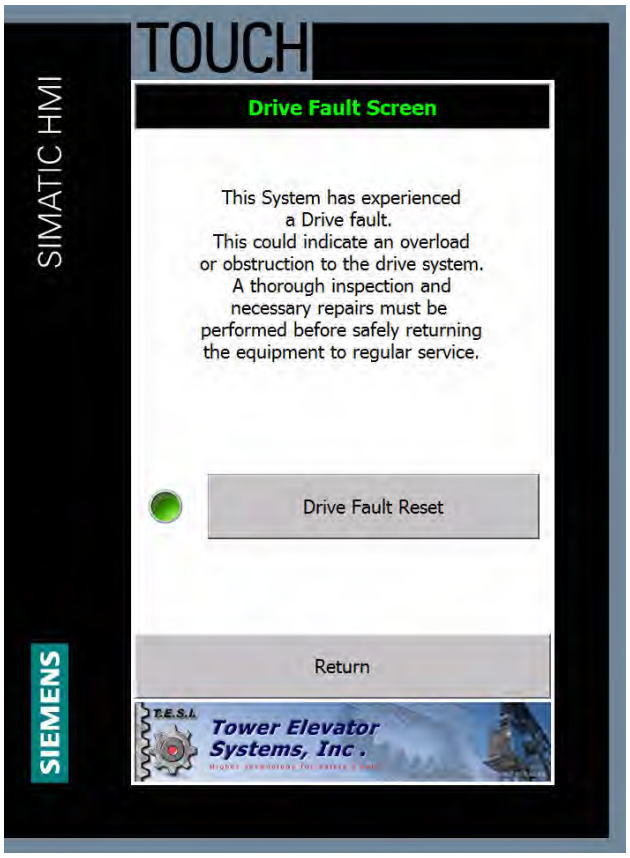
The Fault screen displays a message with instructions that must be read and acknowledged before the fault can be cleared. Once the message is acknowledged by pressing the onscreen button, a second "hidden" button will be displayed allowing the technician access to reset the Hydraulic Hours timer.

Note: To restart the maintenance cycle tracking in the event that the oil is changed prior to 1,000 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.



6.7 VFD DRIVE FAULT:

The VFD Drive Fault indicates a problem with the Variable Frequency Drive that controls the operation of the Main Drive Motors. This fault could indicate some obstruction or overload of the drive system.



6.8 SYSTEM TROUBLESHOOTING

6.8.1 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.

6.8.2 Safety PLC System Passivation

The TRAC-CAB Elevator Controller is based on the Siemens S7 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.

6.8.3 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.

6.8.4 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. All E-Stops must be returned to the normal "out" position, 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.

6.9 QUICK CHECK PROBLEM SOLVER

Symptom	Possible Cause	Solution
No Power or Main Power Fault	1. Check Main Disconnect Fuses. 2. Check OS1 Control Transformer Secondary Voltage (T-1) 3. Check 24 VDC power supply operation	Turn on disconnect, replace damaged fuses, or contact electrician for diagnosis.
VFD Drive Fault	1. Overloaded Cab 2. Obstructed Cab 3. Safety Brakes set 4. Damaged encoder 5. Damaged wires 6. Overheated VFD	Turn off Main Power to reset the VFD (Variable Frequency Drive), Check the travel path for Obstruction or overloaded Cab. Check for an Over Speed Safety Governor Fault or contact electrician for diagnosis. Install the VFD HMI and read the fault history for detailed information on the fault.
Over Speed	1. Independent Over Speed Actuation 2. An uncontrolled drop of the cab.	Acknowledge and Reset the Alarm. (Requires an E-Stop acknowledge also) Verify the electrical circuit and mechanical connections associated with the Overspeed Safety are working. Extensively examine and test the electrical and mechanical components of the Cab braking circuits.
Motor Thermal Overloads (Safety System)	1. Damaged Motor 2. Damaged Wires	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
Hydraulic Oil Level Fault	3. Check Reservoir Level 4. Check for Oil Leakages	Refill Reservoir, Repair Leaks, Check sensor wiring and fuses.
Over Travel Alarms	1. Check for damaged wires or Over Travel limit switches 2. Check for damaged fuses in OS1 3. Check Floor positions for proper position	Replace damaged or broken wires, switches or fuses. Commission floor levels if necessary
Emergency system	1. Active or damaged E-Stops or wires 2. Damaged fuses	Replace Switches or wires if Damaged. Replace damaged fuses
Door Interlocks	1. Damaged switches or wires. 2. Damaged fuses	Replace Switches or wires if Damaged. Replace damaged fuses
Encoder	Virtual condition	This error occurs when the cab exceeds

Speed Error		the speed conditions set in the PLC program. Check to see if the VFD drive parameters have been altered from the commissioning set points. This condition only is measured at “Travel Speed.” If the encoder has been replaced this error would indicate the wrong type has been installed.
Calibration	Virtual condition	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.
120VAC Power Fault	Missing Voltage	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

SECTION 7: EMERGENCY OPERATION

7.1 EMERGENCY OPERATION OVERVIEW

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.

7.2 EMERGENCY COMMUNICATIONS

The Trac-Cab includes Emergency Communications consisting of an Industrial Telephone Handset with keypad connected to an external telephone line. The telephone receives its power from the telephone line; therefore, no external power source is needed in the event of a system power failure. The telephone commonly ties into the control room. The operator may have to manually place a rescue call. Phone service operation is site specific.

7.3 EMERGENCY LIGHTING

The Trac-Cab is equipped with an emergency light. In the event of power loss, this light will automatically illuminate, powered through a battery backup built into the light.

Once power is restored, the light will resume to being powered with 120v, the normal power in the travel cable.

It is recommended that this light be tested at least monthly by pressing on the Test red button on the light fixture inside the cab.

7.4 FIRE PERSONNEL SERVICE MODE

This TC3800 is equipped with a Firefighter’s Service Phase II Emergency In-Car Operation mode. When activated via the key switch, automatic operation is suspended and all landing floor call buttons are disabled. This mode gives the operator in the car dedicated control. Floor call buttons in the car remain active. All landing doors must be closed with system ready indicator for operation.

Ref. ASME A17.1 Safety Code for Elevators and Escalators

> ***2.27.3 Firefighters' Emergency Operation: Automatic Elevators***
> Firefighters' Emergency Operation shall apply to all automatic elevators, except as follows:
> (a) where the hoistway or a portion thereof is not required to be fire-resistive construction (see 2.1.1.1), the rise does not exceed 2 000 mm (80 in.), and the hoistway does not penetrate a floor
> (b) in jurisdictions enforcing the NBCC where the NBCC does not require Firefighters' Emergency Operation

7.5 SAFETY PLC E-STOP FUNCTION

The Trac-Cab is controlled by a Fail-Safe Safety PLC controller. Safety PLCs 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. 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. All E-Stops must be returned to the normal "out" position, if all conditions have been met, the Safety System Ready light will return.

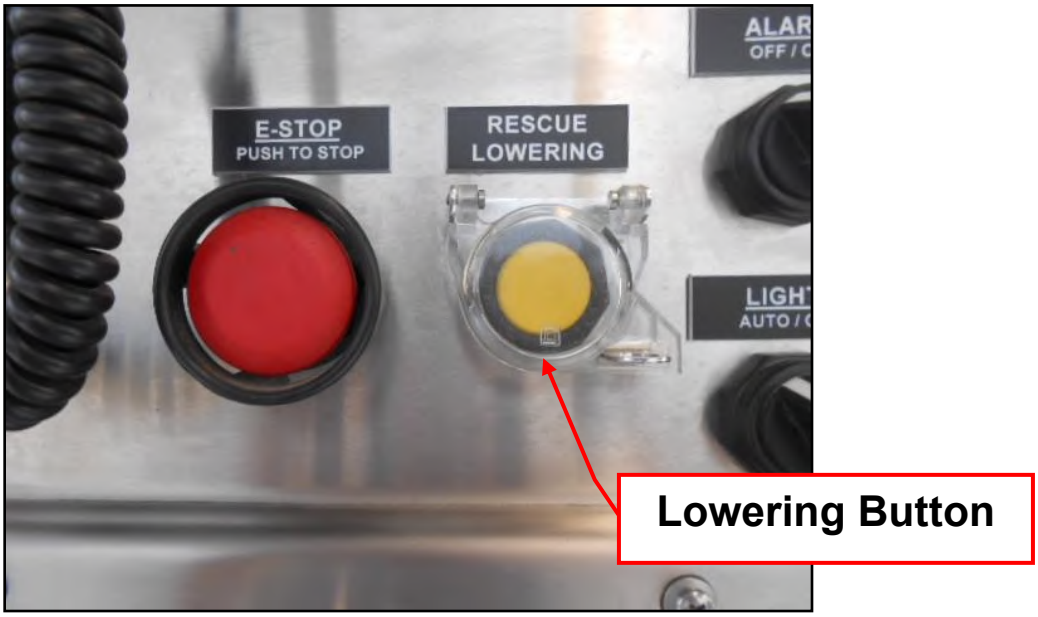
7.6 EMERGENCY LOWERING OPERATION

The TESI Emergency Rescue Lowering System (US Patent US8191689) 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 is considered an Emergency Operation and would only be used in the event that a rider is stranded in the elevator and requires rescue

IMPORTANT: Prior to executing an emergency rescue descent, contact Support Personnel at the Ground Level Landing with the in-car point to point intercom, 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.

- Contact Ground Level Landing 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



Please see Section 8, ***System and Subsystem Details***, in this Operations Manual for additional information on TESI's patented Lowering System.

SECTION 8: SYSTEM AND SUBSYSTEM DETAILS

8.1 REVIEW OF RACK AND PINION DESIGN

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 is 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 an independent rack and pinion Safety.

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 a 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, Rossi VFD speed controller and the Rossi 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 zed 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.

8.2 SINGLE DRIVE AND SAFETY FUNCTIONAL & DESIGN OVERVIEW

This section will review the design and engineering of the TESI Rack and Pinion Single 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.

8.3 TESI RACK AND PINION SAFETY OVERVIEW

Reference ASME A17.1

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.*

8.4 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 an 8:1 safety factor at all times.

8.5 FREELY ROTATING SAFETY PINION

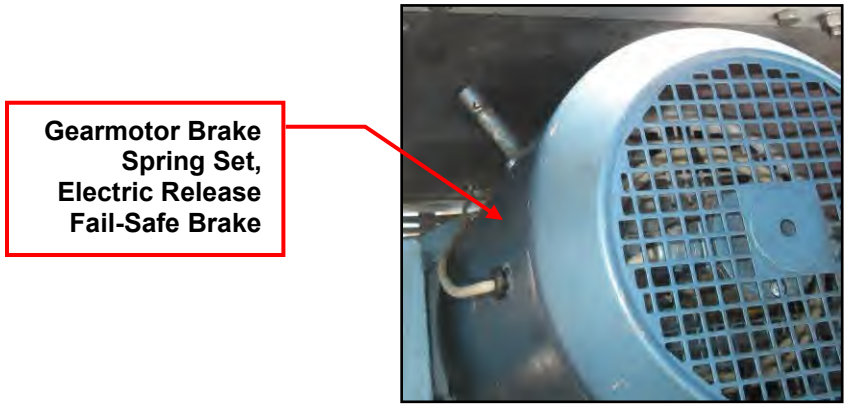
A Freely Rotating Pinion, which is in motion any time the car is in motion, drives the Speed Governor. The rotating pinion driving the speed governor is in full time mechanical engagement to the rack.

8.6 FAIL-SAFE PARKING BRAKES

In addition to the centrifugal force brake, 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 are engineered to stop and hold more than 300% of the rated dynamic load.

TESI has worked closely and extensively with Rossi engineering teams to ensure the Drive and Gearmotor technology has been implemented according to their design specifications for safety and functionality.



8.7 SAFETY RATED INDUSTRIAL PLC CONTROLLER

TESI elevator controllers are UL Classified and engineered around the Siemens SIMATIC 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 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 Safety PLC’s have a published probability of total error in 1 hr. of continuous operation of less than 0.00000001129 (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.

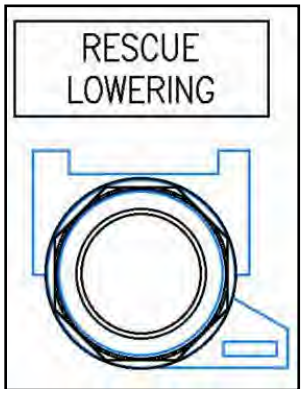
The benefit of using FS PLC control for elevators is reduction of the risk of injury and property damage. Manufacturers, owners, and riders can have greater confidence in the reliability of the system performance through the use of this higher technology.

8.8 EMERGENCY RESCUE LOWERING

The TESI Emergency Rescue Lowering System (US Patent US8191689) 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.



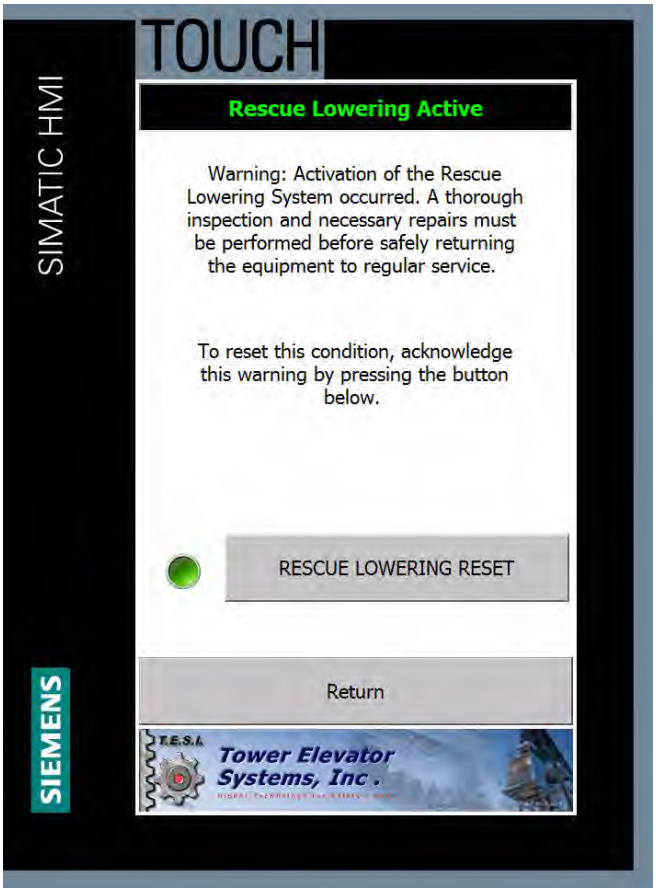
The elevator control system also senses if the Lowering operation has occurred and indicates a “lowering activated” alarm. The lowering activated alarm will disable automatic operation until a trained technician can inspect and reset the fault prior to placing the system back in normal operation.

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.



8.8.1 DESCRIPTION OF EMERGENCY LOWERING MECHANISM

The TESI Emergency Rescue Lowering® System (US Patent US8191689) 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.

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 permanently plumbed 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.



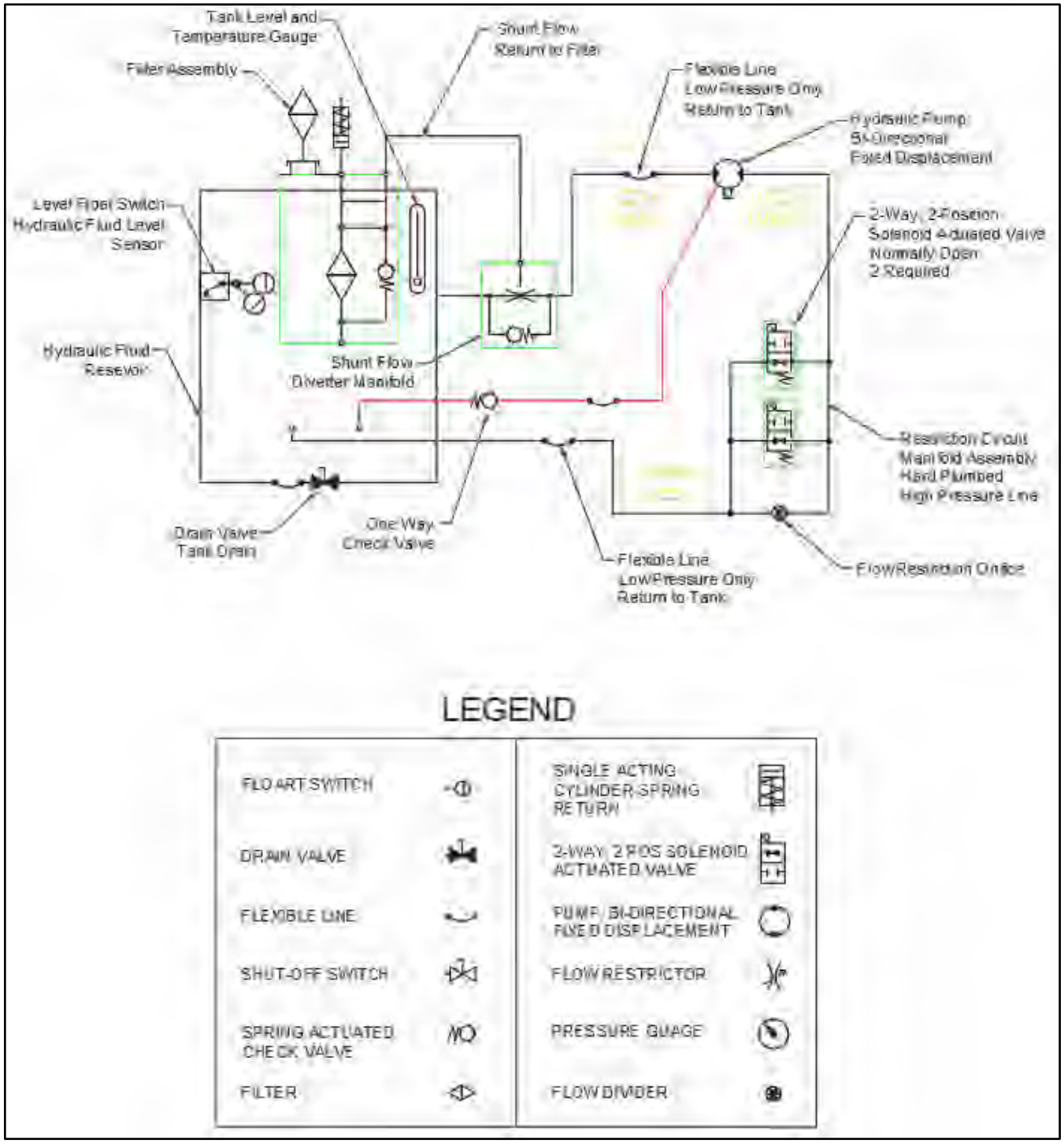
In simple terms, when the brakes are released, the pump is connected to the elevator pinion gear, and can only turn as fast as oil can be pushed thru the small restriction, thus limiting descent speed.



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 accomplished by actuating a hydraulic solenoid valve, allowing the oil flow to bypass the restriction.

8.8.2 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 system is always engaged in a Fail-Safe mode when the machine is at rest providing yet another redundant safety system.



The system incorporates an onboard UPS (uninterruptible power supply) that provides 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 Elevator Safety Over-Speed system also remains active during lowering, even when main power is disconnected.

Basic Functional Operation:

- Push the “LOWERING” button
- 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.

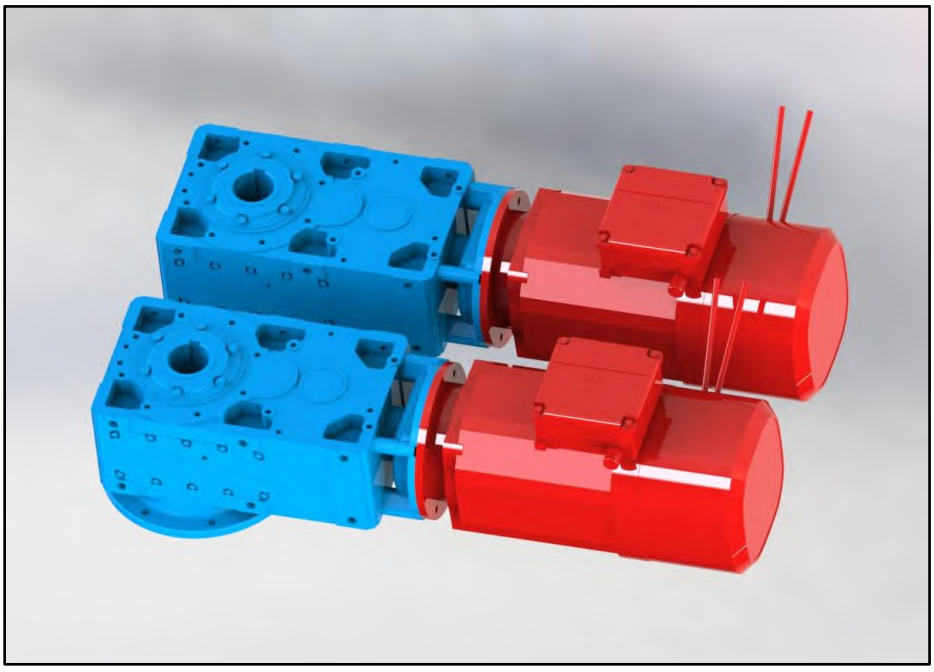
8.9 ROSSI RIGHT ANGLE GEARBOX WITH SEW MOTOR 30HP – 2 REQUIRED

Motor Model:
TESI Part / Model # - DRN160L4/BE20HR/FF/TH/C

- SEW BE20 1770[lb.-in] direct acting brake with BGE3 Brake Rectifier
- SF1.15
- Voltage: 460 VAC / 3 Phase / 60Hz 25A
- Weight: 300 lbs. each
- Size: 20 HP

Worm Gearbox Model:
TESI Part/ Model # - MR V 160 UO2A – 42 X 350 - 25

- Ratio: i = 25.1
- Mounting Position: B6
- Service Factor: 2.30
- Flange Adapter: Bolt-on Flange Kit
- Weight: 370 lbs. each



8.10 ABSOLUTE ROTARY ENCODER

The basic principle of recording absolute measurement values is optical sensing of a transparent disk with a printed code that is connected to the shaft to be measured. This allows the system to be exactly located at all times even with loss of power or when the rescue lowering function has been activated.



SECTION 9: INSPECTION AND MAINTENANCE

9.1 MAINTENANCE INTERVAL SCHEDULE

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.

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

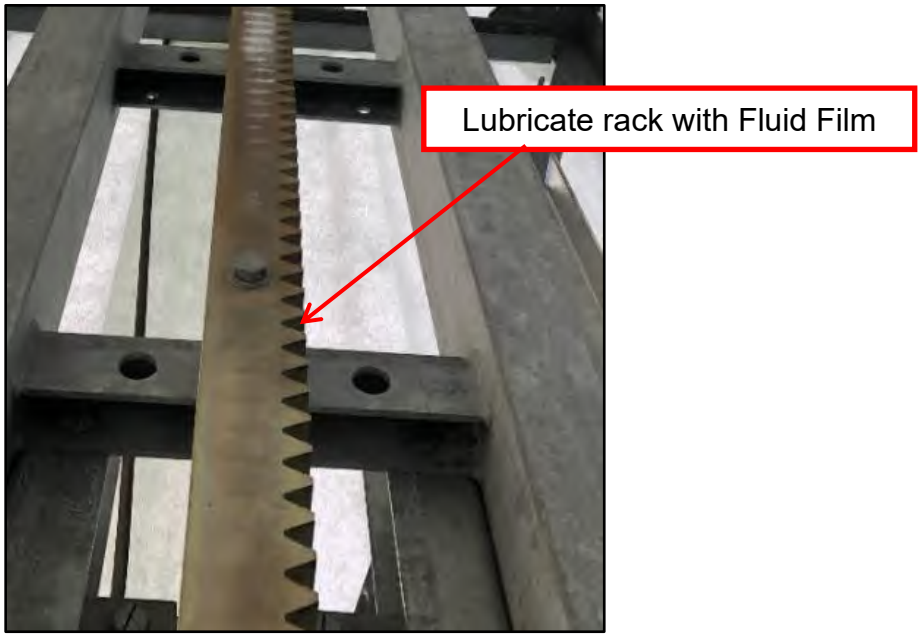
Recommended Interval and Procedure:

Note: heavy use may require more frequent inspection and lubrication

9.1.1 Every 3 Months: Inspection, Maintenance and Lubrication

A visual inspection by a **competent person** should be performed 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 Counterweight System; including top sheaves, support cables, attachment points and guide track (if applicable)
- Thoroughly inspect the Energy Chain cable and carrier, guide panels, and support channels
- Lubricate, but do not over lubricate, the Rack and Gear System with Graphite Based Dry Spray 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)

Lubricate landing door interlocks with Fluid Film



Lubricate door rail and interlock with Fluid Film



- 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 the oil level in the gearboxes and add if necessary
- Verify all safety signage is intact

9.1.2 Annually or 300 Hours of Use: All from above, plus the following

- *Perform 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 in the hydraulic oil reservoir
- Change the gearbox oil in the gearboxes per manufacturer's instructions
- Inspect all components under the Car Top Mechanical Enclosure Cover
- Inspect and Re-Certify Fire Extinguisher

9.1.3 Five Year Intervals:

- Perform a complete system inspection and function proof test by a Certified Elevator Technician
- Perform all State required testing and reporting

9.1.4 Competent Maintenance Person / Elevator Technician

This may vary depending on the local "Authority Having Jurisdiction" over the Elevator installation. In some cases, only a licensed elevator mechanic may service an elevator. At minimum, this is recommended for the 5-year inspection. In general, a qualified competent person, by way of training and/or experience, is knowledgeable of applicable standards, is capable of identifying issues relating to the specific operation of the system, and has the authority to correct them. This person should have working knowledge of the operations manual, and be authorized by the owner to perform scheduled lubrication and maintenance.

9.2 CHANGING THE RESCUE LOWERING HYDRAULIC OIL

Replacement Interval:

- Each 3 YEARS or 1,000 hours of operation; whichever occurs first.

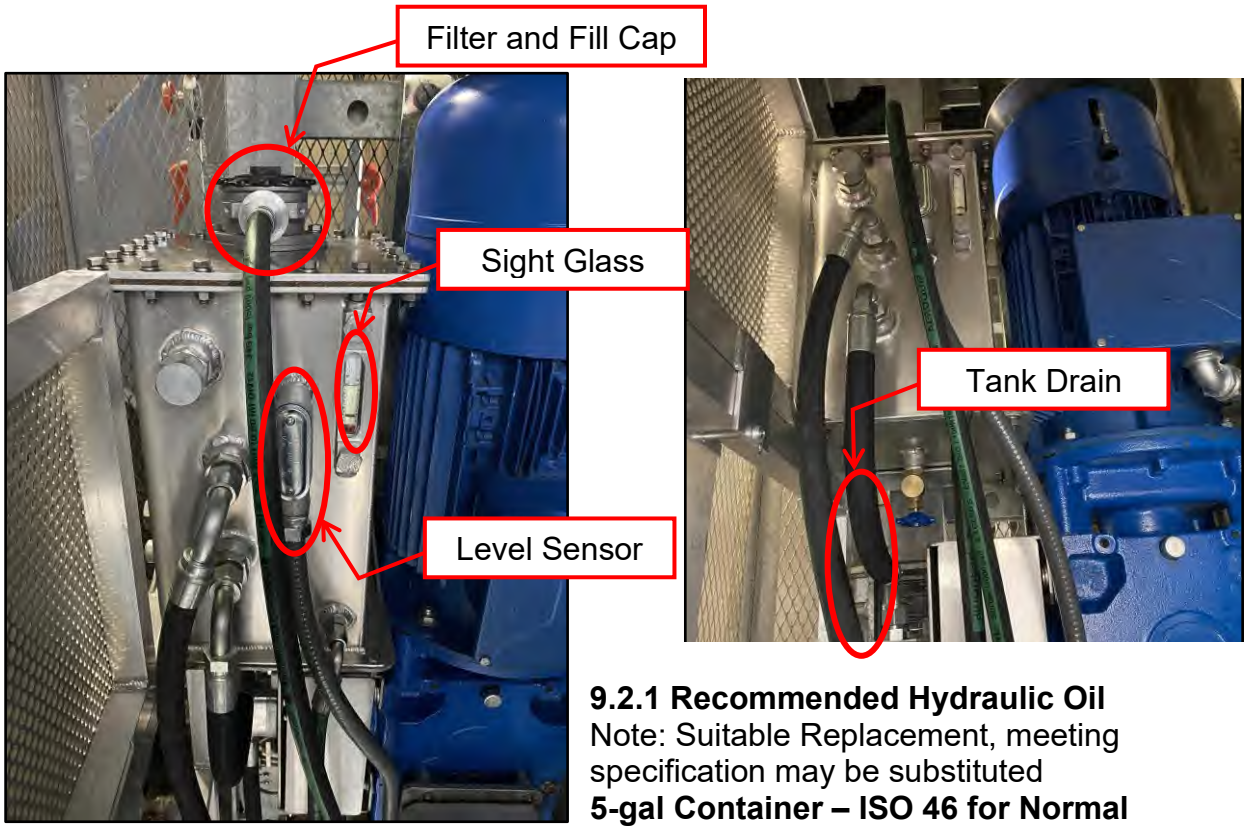
The control system tracks hours of operation while the drive motors are running. This information can be found on the Drive System Screen. When the system has reach 1,000 hours of operation, a drive fault will be indicated along with the hydraulic operation fault.

The Hydraulic Timer Fault will appear after 1000 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. The tank can be refilled by removing the fill cap on the filter. The hydraulic tank has a maximum capacity of 7 gallons. However, it should be filled with 5.5 gal to 6 gal to ensure proper system function.

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.



9.2.1 Recommended Hydraulic Oil
Note: Suitable Replacement, meeting specification may be substituted
5-gal Container – ISO 46 for Normal Operating Conditions

EXXONMOBILE HUMBLE HYDRAULIC H 46

Humble Hydraulic H Hydraulic Oil Product Description

The Humble Hydraulic H Series oils are quality anti-wear hydraulic oils designed to meet the requirements of most fluid power systems. They exhibit good anti-wear properties that help reduce the wear rates in gear, vane and piston pumps. They also possess a high level of resistance to oxidation and thermal degradation that helps control the formation of system deposits. The Humble Hydraulic H line also has good water separation properties, rust and corrosion prevention, and foam resistance. They are formulated with high quality base oils and a performance additive system.

Features and Benefits

The Humble Hydraulic H Series oils provide good anti-wear protection reducing wear in pumps and actuators in open or closed-loop systems. Their high resistance to oxidation and thermal degradation helps reduce the formation of deposits and varnish.

The Humble Hydraulic H Series offers the following benefits:

- Good anti-wear protection improves pump life
- High resistance to oxidation eliminates deposit formation and improves oil life
- Good water separation properties allow easy removal of water from systems reducing potential damage to system components

Applications

- Fluid power systems prone to deposit and varnish formation
- Hydraulic systems using gear, vane and piston pumps
- Hydraulic pumps and components requiring anti-wear fluids

Typical Properties

ISO Viscosity Grade	46
Viscosity @ 40ºC (ASTM D 445)	44.5 cSt
Viscosity @100ºC (ASTM D 445)	6.7 cSt
Viscosity Index (ASTM D 2270)	95
Pour Point (ASTM D 97)	-18 ºF
Flash Point (ASTM D 92)	216 ºC / 421 ºF
Demulsibility (ASTM D 1401)	40/40/0 (15)
Vickers 104C (IP281)	Pass
Vickers M-2950-S	Quality Level
Vickers I-286-S	Quality Level
TOST (ASTM D943)	2000+

Health and Safety

Based on available information, this product is not expected to produce adverse effects on health when used for the intended application and the recommendations provided in the Safety Data Sheet (SDS) are followed.

9.3 RACK AND GEAR LUBRICATION



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

FLUID FILM AEROSAL

FLUID FILM is a penetrant and lubricant also used for corrosion prevention. It is a non-toxic, long lasting, thixotropic liquid that has been used for over fifty years in the highly corrosive marine environment of ships and offshore drilling rigs. More recently they have been introduced and successfully utilized in the aerospace, aircraft and automobile industries as well as for home maintenance. Facilities where they are used include the following: government facilities, commercial fishing concerns,

gas companies, agriculture, salt plants, municipal plants, power plants, manufacturing plants and pulp and paper mills.

FLUID FILM is formulated from specially processed wool-wax, highly refined petroleum oils and selected agents to provide corrosion control, penetration, metal wetting and water displacement. The long-lasting product contains no solvents, will not dry out and will penetrate to the base of all metals, providing corrosion protection from both natural and industrial atmospheres. Heavily corroded and/or frozen parts such as nuts, bolts, shafts, etc. that would normally be damaged during maintenance, can be salvaged by applying FLUID FILM.

9.4 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.