Standard Operating Procedure

Tire Scanner Machine (TSM)

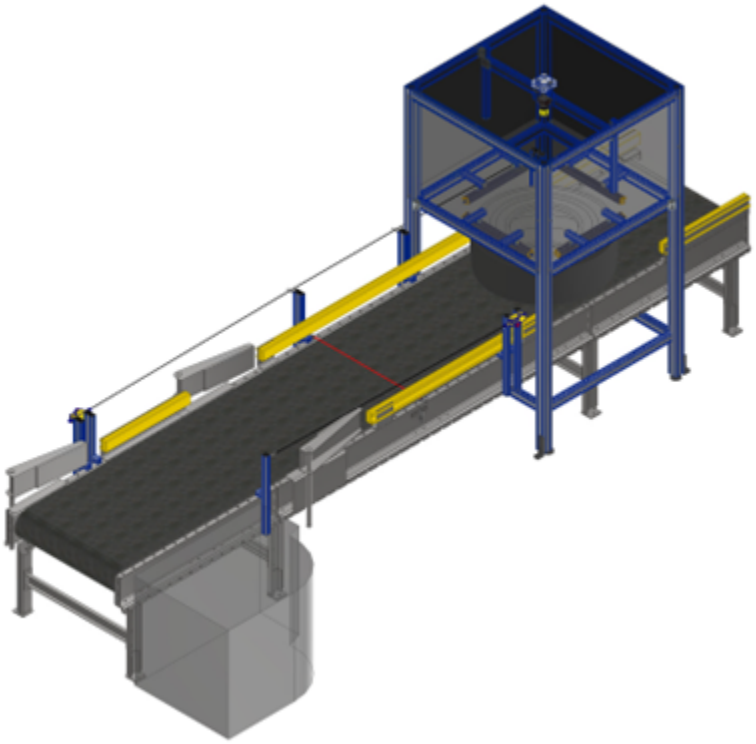


Table of Contents

Definitions

- **TSM:** Tire Scanning Machine. An inline machine inspection station used to determine if a tire passes certain safety standards.
- **HMI:** Human Machine Interface. Details the current state of the machine and the tires and instructs the operator via a screen.
- **IPC:** Industrial Personal Computer.
- **VFD:** Variable Frequency Drive motor.
- **DOT:** Department of Transportation.

Purpose

This document outlines the proper and safe use of a TSM.

During the production process of tires, each tire is scanned by a TSM to determine if it passes safety standards detailed by the DOT. For each tire, data is collected, stored, and then compared to these standards using a network. If the tire passes, it automatically continues on the production process via a conveyor. If the tire fails the inspection, it is manually removed from the conveyor.

Safety Measures

The TSM contains an E-Stop button. Pressing this button cuts off all power to the TSM's moving parts and the light tower flashes red. Recovery from an E-Stop event is detailed in the Fault Recovery section.

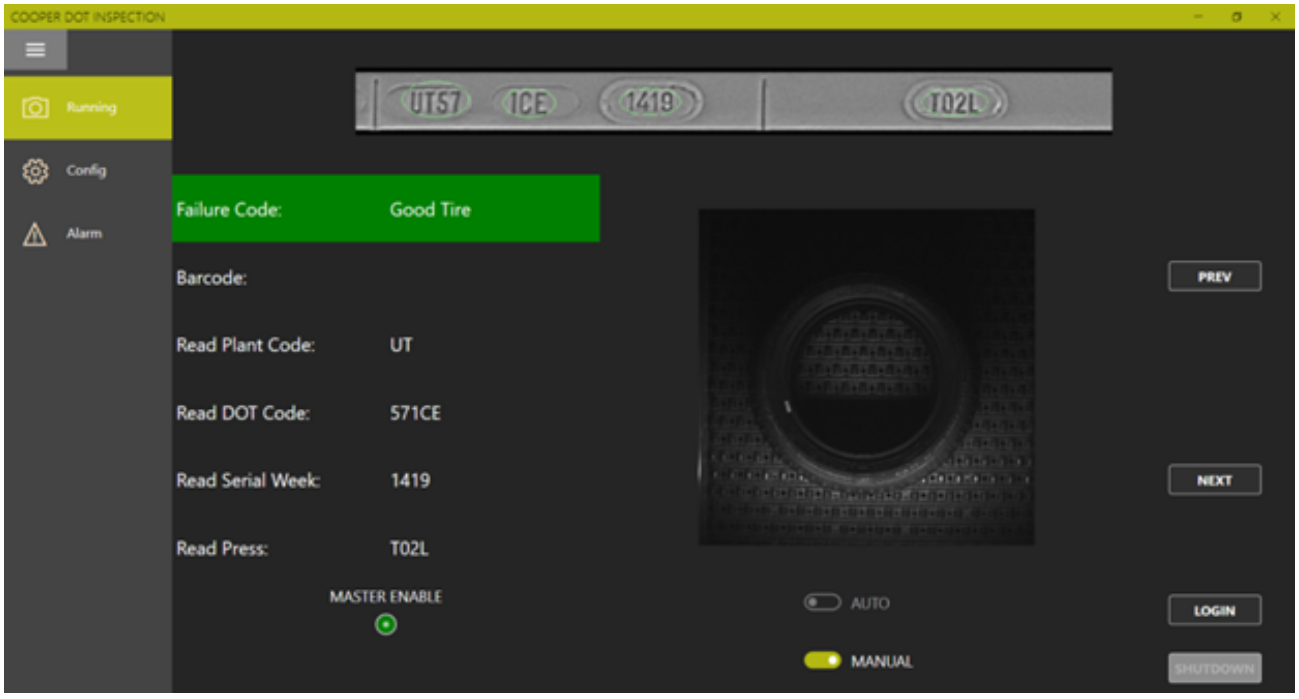
TSM Anatomy

Component	Description	Purpose	Image
E-Stop	Self-latching Red mushroom button (protruding from the TSM)	Stops all moving parts of the TSM	
Cycle Start	Green button	Starts the TSM	
Cycle Stop	Red button (flush with the TSM)	Allows the completion of the current cycle then stops TSM	
Master Enable	Toggle switch	Toggles TSM into Auto/Manual mode	
Manual Feed Tire	Yellow button	Manually requests a new tire from conveyor	

Reset Button	Blue button	Resets TSM	
Light Tower	A light post that can flash green, blue, yellow, or red	Signals to the operator the state of the TSM and the subsequent required steps of operation	

HMI

During operation of the TSM, the current state of the TSM and the tires are provided by an HMI. Requests and instructs are provided to the operator via this screen.



Procedure

P.1: **Toggle** TSM to auto mode.

P.2: **Press Cycle Start**. The light tower flashes green. The Regular Process starts (skip to step P.4). If the TSM was just toggled into auto mode from manual mode, a Purge Cycle occurs first, then the Regular Process starts.

P.3: **The Purge Cycle starts**. The conveyor starts and transports unexpected tires or tires from the previous shift to the scanner. The HMI prompts manual removal of tires once they reach the scanner during this process.

P.4: **The Regular Process starts**.

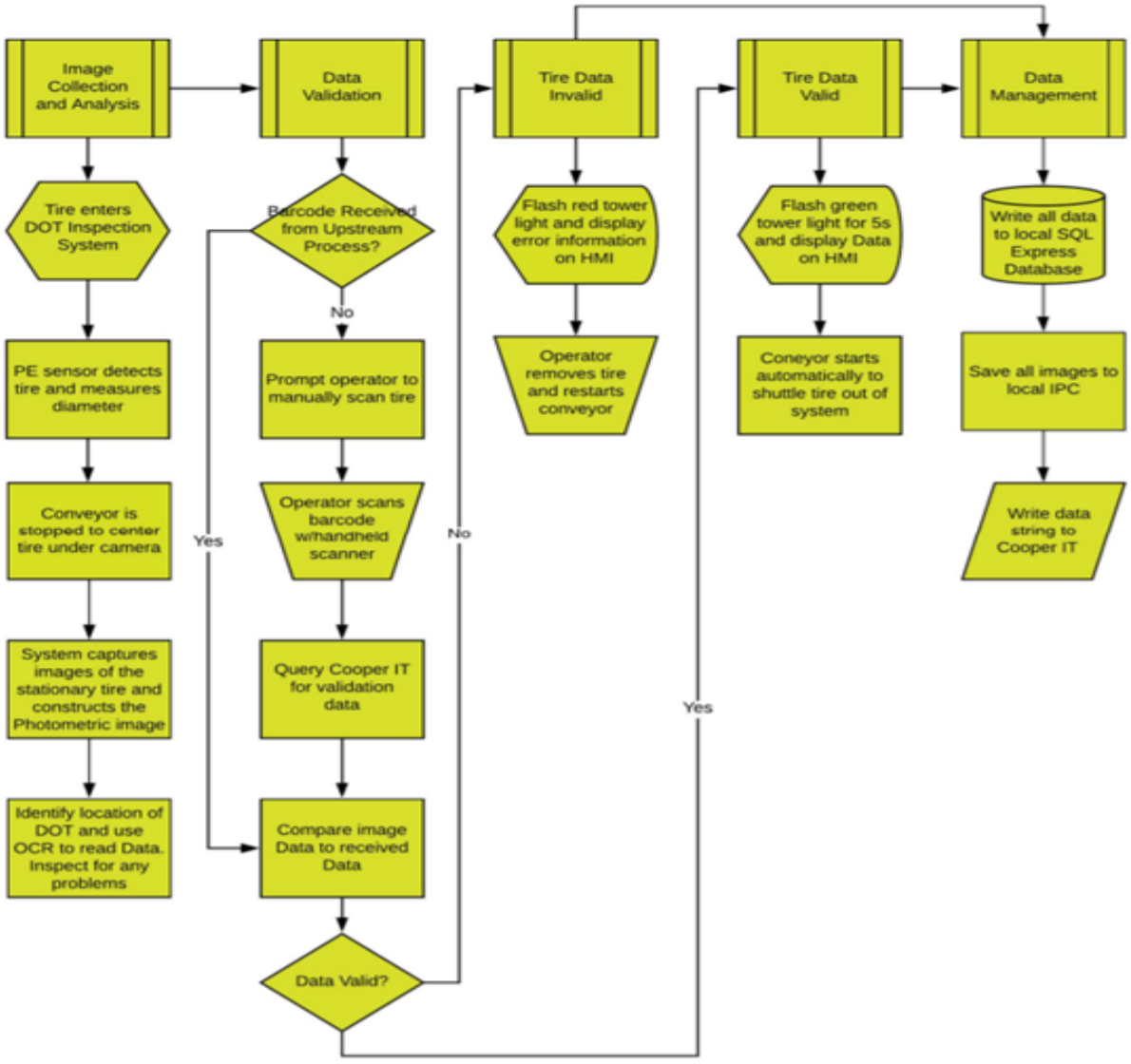
- P4.1: A tire from the outfeed conveyor is shuttled towards the scanner. Via the beam sensor, the tire's diameter is measured to center the tire under the scanner.
- P4.2: The conveyor automatically stops when the tired is centered under the scanner.
- P4.3: The vision system triggers and takes four images with each one of the bar lights illuminated. The TSM analyzes the image results and takes another set of four images if needed.

P.5: If data is successfully retrieved, skip over step P.6 and proceed to step P.7.

P.6: If data is not successfully retrieved, the HMI prompts the operator to:

- P6.1: Manually remove the tire from the conveyor.
- P6.2: Scan the tire with the handheld scanner. The HMI displays the scan results.
- P6.3: If the tire passes, place the tire back on the conveyor. Otherwise, leave the tire off the system.
- P6.4: Press the Cycle Start. This starts the Regular Process for the next tire.

P.7: The HMI displays the scan results. If the tire passes, the tire is shuttled out of the system by the conveyor. The Regular Process is automatically started for the next tire. If the tire fails, manually remove the tire from the conveyor. Press Cycle Start to start the Regular Process for the next tire.



Fault Recovery

To recover from an E-Stop event:

FR.1: Pull out the E-Stop button, and twist. This unlatches and resets the E-Stop button. The light tower blinks blue.

FR.2: Press the machine reset button to reset the TSM. The light tower turns orange.

FR.3: If no tires are on the conveyor, the TSM is recovered and ready to begin a cycle (skip step FR.4 and proceed to step P.1.).

FR.4: If a tire is on the conveyor, it must be manually removed. To do this:

- FR.4.1: Toggle TSM to manual mode.
- FR.4.2: Press Cycle Start. The conveyor turns on.
- FR.4.3: Press Cycle Stop to stop the conveyor once the tire is under the scanner. Manually remove the tire from the conveyor. The TSM is ready to begin a cycle (proceed to step P.1.)

Quality Specifications

The TSM collects the following data on variously sized tires:

- DOT code
- Barcode

Tires either pass or fail based on the following:

- Legibility of information
- Misplaced information
- Poorly located information
- Upside-down characters

Equipment Specifications

Attributes of the TSM

TSM Attribute	Value
Equipment Size (W x D x H)	1.1 m x 2.0 m x 1.0 m
Equipment Weight (Approximate)	150 kg
Electrical Power	440 - 480 VAC, 3-Phase, 60 Hz, 10 A
Temperature	40 - 130℉ (5 - 55℃)
Relative Humidity	0 - 95% (non-condensing)

Parameters of the VFD

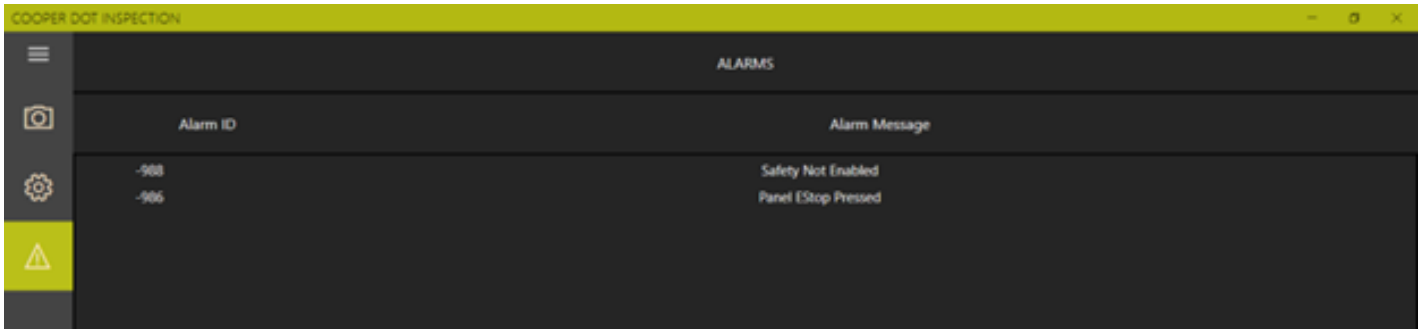
Description	Number	Setting Value
Control Method	A1-02	Open loop vector
Input Supply Voltage	E1-01	480 VAC
Motor Current (FLA)	E2-01	1.56 A
Motor Resistance	E2-05	19.392 Ω (Ohms)
Correction Factor	Q1-02	1.85%

Part Specifications

Part	Manufacturer	Part Number	Quantity
Power Supply	Eaton	PSG240E24RM	1
Prosilica GT4096 camera	Allied Vision	02-2688D	1
IPC	Advantech	UNO-2484G-7531AE	1

Alarm List

When an error occurs while operating the TSM, a respective alarm code is displayed on the HMI. The following table is a reference to each code and its corresponding message.



Alarm Code	Message
944	No barcode data received
946	Machine not enabled
947	Tire not centered
948	Timeout waiting for vision
949	Timeout taking images
950	Timeout waiting for tire to reach camera
976	TCP Tx not connected
977	TCP Rx not connected
978	Camera not connected
988	Machine in E-Stop
989	VFD overheating
999	Heartbeat lost

FAQs

Q: Does the TSM weigh the tires?
A: No. This machine does not collect weight data. A comprehensive list of the TSM's analysis suite is detailed in the Quality Specifications section.

Q: Why does the TSM measure the diameter of each tire?
A: The diameter of the tire is measured so that the center of the tire can be perfectly aligned with the scanner. The diameter of the tire is not a quality specification.