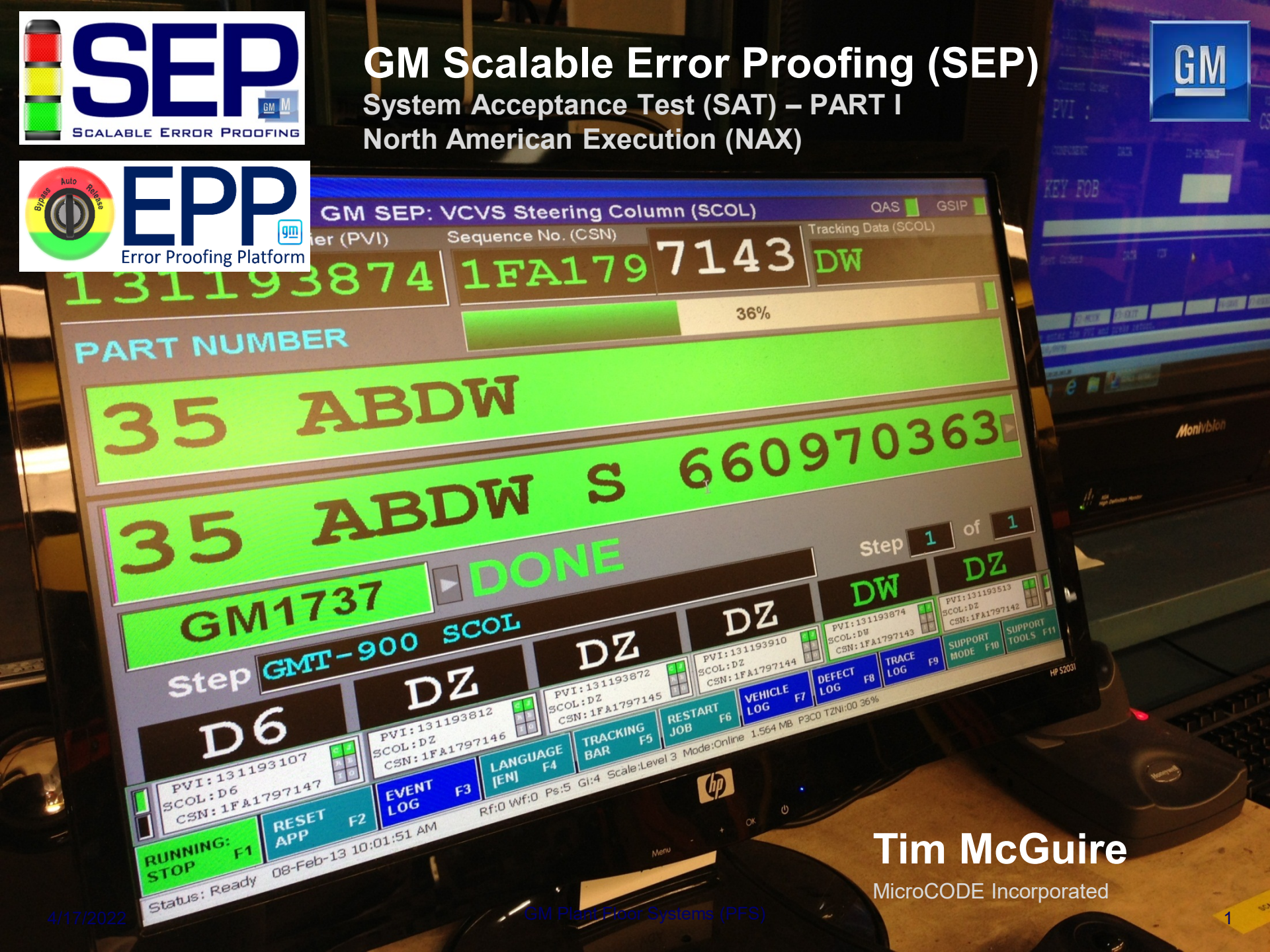
GM Scalable Error Proofing (SEP)

System Acceptance Test (SAT) – PART I

North American Execution (NAX)



Tim McGuire

MicroCODE Incorporated

SEP/EPP Overview

Overview of **terminology** in use describing SEP/EPP System components.

- **COSS = GEP = SEP/EPP**– each rename corresponded to a Project to improve the existing error proofing system

- **EPP** = Error Proofing Platform, a new GCCS-2 'like' system

Note: *Currently Plants use the terms **GEP** and **SEP** interchangeably because many SEP software components are still labeled "GEP"*

- **Hardware** – physical components, both IT and Controls
- **Software** – 3rd party and GM proprietary
- **Configuration** – data collected and input into system during deployment and system maintenance

SEP/EPPOverview – Hardware

Hardware components used for Error Proofing…

- **SEP/EPP Server** = A Windows Server with SQL Server database, Rockwell RSLinx communication software, GE Fanuc CIMPLICITY HMI software, and SEP/EPPApplication components.
- **SEP/EPP Cell Controller** = An Allen-Bradley Logix 5000 Chassis, Power Supply, PLCs, and Interfaces Cards in an enclosure on the plant floor.
- **Tin Can** = “NEMA-12 / PanelView 600 LTC” the original COSS Line Tracking Console (LTC) Device from 15 years ago*, replaced by…*
- **CE Station** = “Black Stand”, “EPC”, “LTC”, a black metal stand with: Windows CE computer, LCD Monitor, Keyboard, Mouse, Hand Scanner, Local Ethernet I/O, Light Stack, and Bypass/Release Keyswitch.

SEP/EPP Overview – Hardware

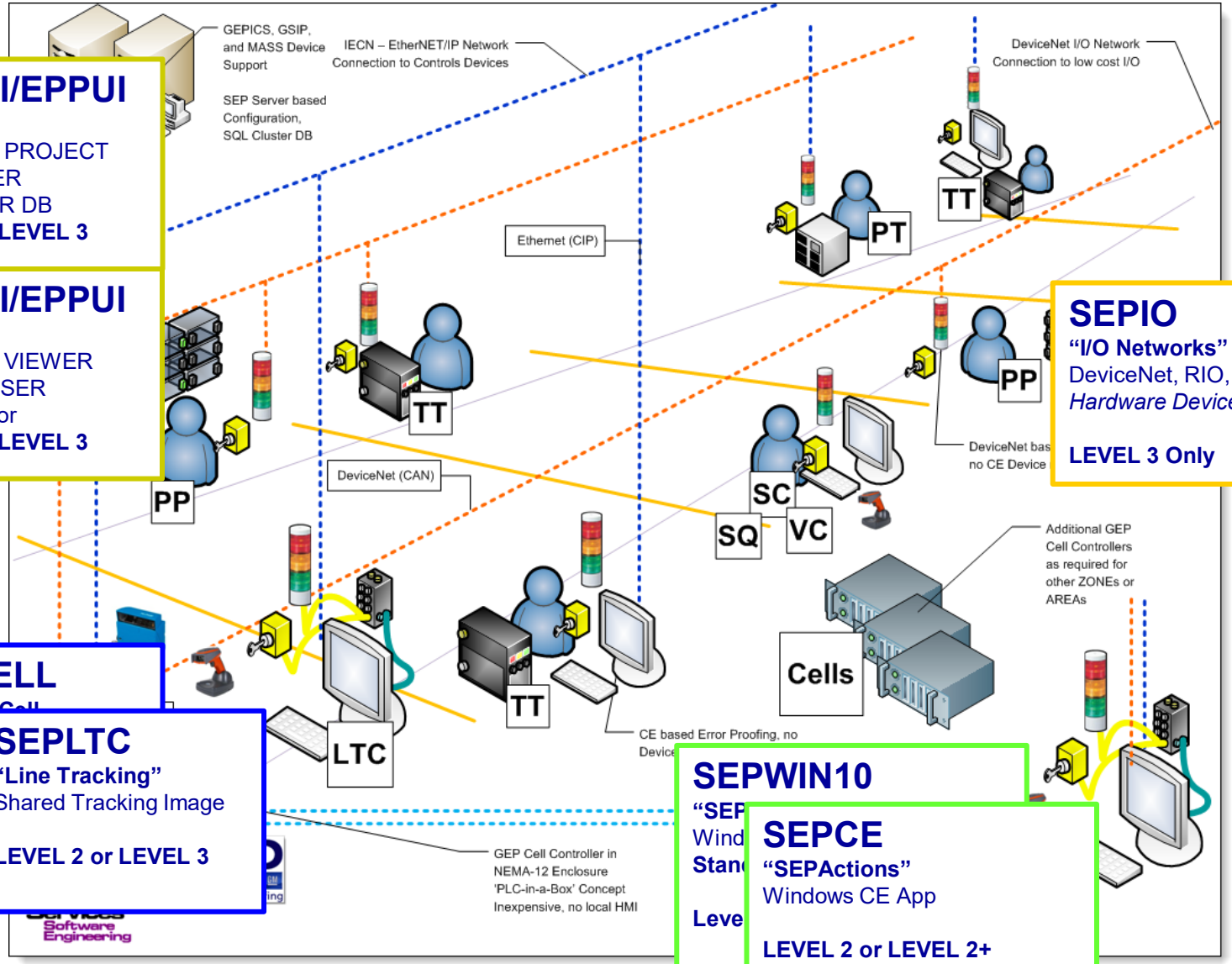
Hardware components used for Error Proofing…

- **O.I.** = Operator Interface, also called SOI (Single), DOI (Double)… includes an I/O Module, Light Stack, and Bypass/Release Keyswitch.
- **I/O** = any I/O module which connects sensors to the SEP/EPP Cell Controllers or CE Stations.
- **Light Stack** = a Traffic Light with a Horn.
- **Bypass/Release Keyswitch** = a three (3) position keyswitch.

1) Center (spring return) – Run error proofing
2) Right (momentary) – Release a single Vehicle from error proofing
3) Left (maintained) – Bypass error proofing for all Vehicles

Note: Only Team Leaders and Group Leaders have B/R Keys on the floor… normally.

SEP/EPP – System Components



SEPHMI/EPPUI
"Server"
CIMPLICITY PROJECT
WEB SERVER
SQL SERVER DB
LEVEL 2 or LEVEL 3

SEPHMI/EPPUI
"Clients"
CIMPLICITY VIEWER
WEB BROWSER
On Plant Floor
LEVEL 2 or LEVEL 3

SEPIO
"I/O Networks"
DeviceNet, RIO, etc.
Hardware Devices

LEVEL 3 Only

SEPCELL
"SEP/EPPCell
Controll
Logix PL

LEVEL 2

SEPLTC
"Line Tracking"
Shared Tracking Image

LEVEL 2 or LEVEL 3

SEPWIN10
"SEP
Wind
Stan

Leve

SEPCE
"SEPActions"
Windows CE App

LEVEL 2 or LEVEL 2+
LEVEL 3 or LEVEL 3+

SEP/EPP Overview – Software

Software components used for Error Proofing…

- **CIMPLICITY Project** = “SEP/EPP HMI”, loaded on the SEP/EPP Server and SEP/EPP Clients (HMIs/UIs) throughout the plant. Common Code. Not modified.
- **GMP, GXP** = Two Allen-Bradley Logix 5000 PLC programs loaded into a Cell Controller. Common Code. Not modified.
- **Console** = “GEP Console” a CE App loaded into a ‘CE Station’, a PV600 emulator that replaced the ‘Tin Cans’ – now replaced by SEPActions SEP App (LTC Action).
- **Sequence** = “GEP Sequence” a CE App loaded into a ‘CE Station’, , a ‘Level 2’ application for sequencing and kitting, i.e.: Part Picks and Scans. Currently there is no SEPActions equivalent.
- **Actions** = “SEPActions” a CE App loaded into a ‘CE Station’, designed as a scalable alternative to all software components in GEP except for a shared tracking image.

SEP/EPP Overview – Software

Software components used for Error Proofing…

- **Conveyor Driver** = PLC-5, Logix 5000, or custom PLC subroutine(s) place in a Conveyor PLC to provide tracking information to an SEP/EPP Cell Controller.
- **Process Tool Driver** = PLC-5, Logix 5000, or custom PLC subroutine(s) place in a Process Tool PLC to provide equipment status to an SEP/EPP Cell Controller.
- **Deployment Tools** = VB Apps, Excel/VBA Tools, C# Apps, Access Tools.

SEP/EPP Overview – Software

External GM Systems that SEP/EPP connects to…

- **GEPICS** = **G**lobal **E**nterprise **P**roduction **I**nformation **C**ontrol **S**ystem, the customer order system as seen by the manufacturing plants, controls Vehicle build order and receives vehicle status.
- **GSIP** = **G**lobal **S**tandardized **I**nspection **P**rocess, controls the tracking of Vehicle quality, receives defects on vehicles from various sources.
- **GPM&C** = **G**lobal **P**lant **M**onitoring and **C**ontrol, a central collection of all plant floor manufacturing systems status, alarms, and data; receives status, counts, alarms and other data from various sources.
- **QAS** = **Q**uality **A**ndon **S**ystem, “Andon” means lantern in Japanese, provides a common means for Operators and Systems to stop Production for defects before they leave a Station, Footprint, or Area.

SEP/EPP Overview – Action/Task Types

Acronyms used for Error Proofing Action types (Task Types)…

- **EPA** = Error Proofing Action, generic type for any type

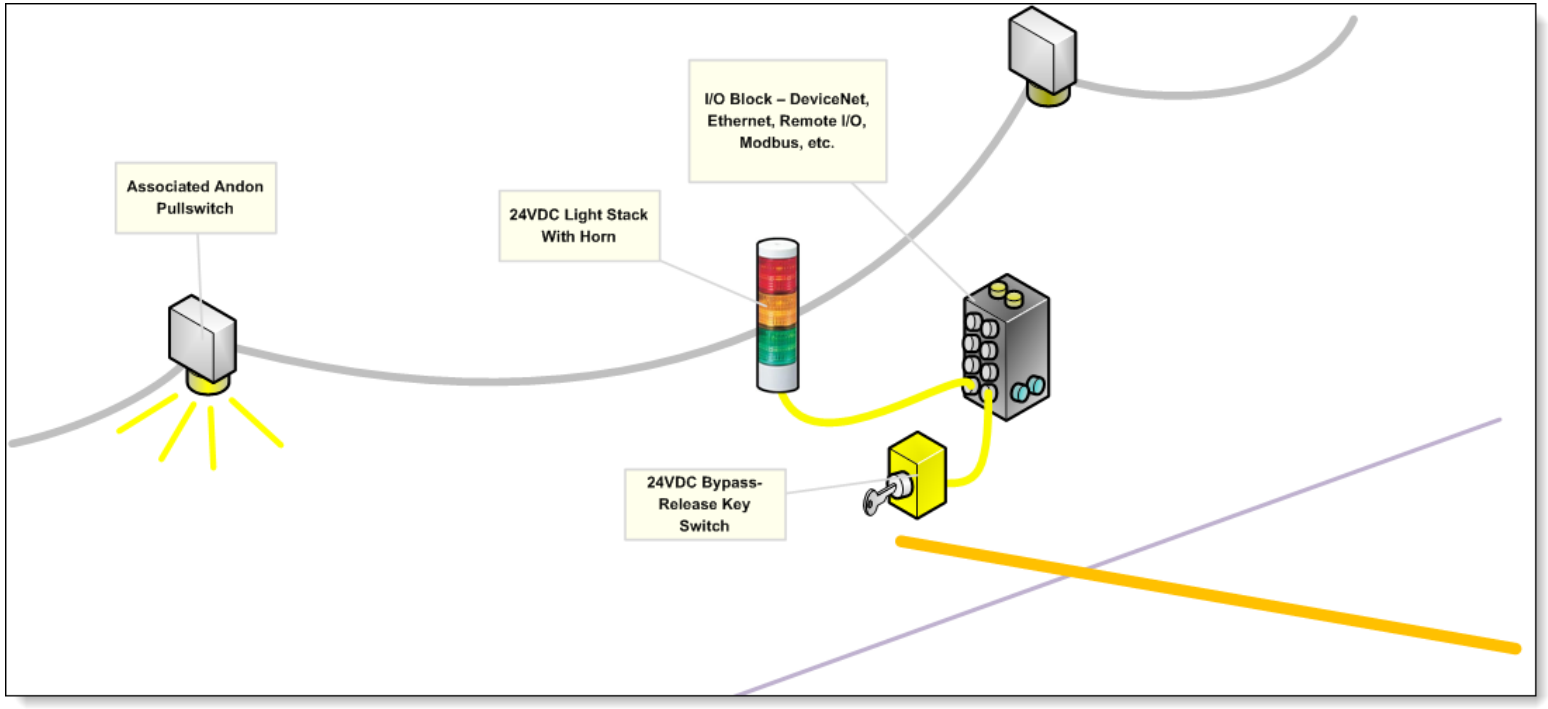
- **LTC** = Line Tracking Console… sensing Vehicle entry and movement

- **TT** = Torque Tool, also called an ‘SSE’ (Single Spindle Electric), ‘Nut Runner’, ‘Electric Tool’, ‘Electric Gun’… these sense the Operator tightening Fasteners on the Vehicle or Sub-Assembly.
- **SC** = Scan Component, also called ‘Part Scan’, ‘Scanners’, ‘Trace Stations’… these sense an Operator scanning a barcode on a selected Part for install on the Vehicle.
- **PP** = Part Pick, also called ‘Light Screens’, ‘Hoppers’, ‘Bins’, ‘Acknowledge Lights’, ‘Acknowledge Buttons’… these sense the Operator picking up optional Parts for the Vehicle.
- **PT** = Process Tool, also called by their specific names, like “Fluid Fill’, ‘Glass Cell’, ‘Fuel Fill’, ‘Body Marriage’, etc…. These sense a remote equipment controller completing a process on the Vehicle.

SEP/EPP Overview – Action Types: EPA

Common to any EPA Type…

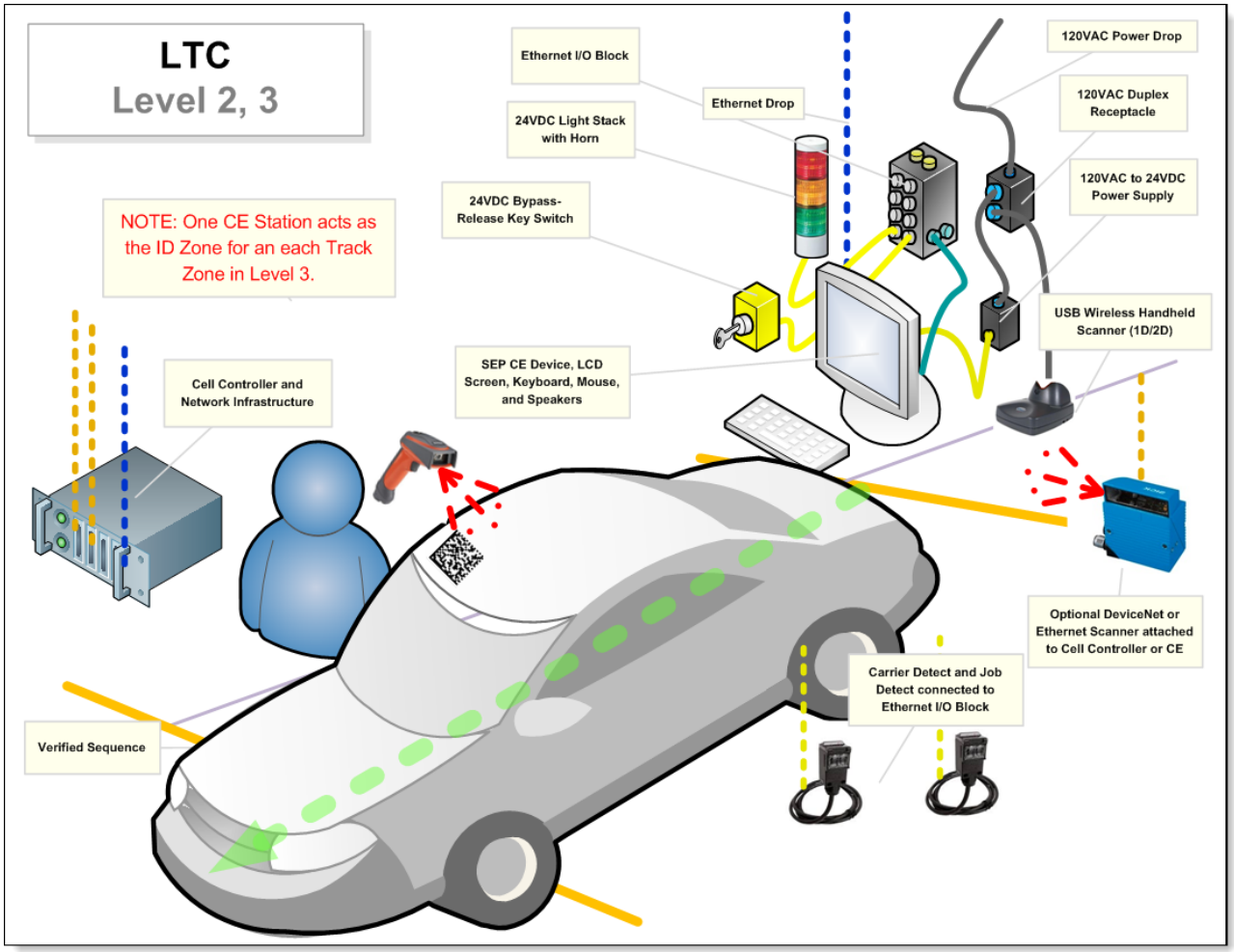
- **Software** = Configuration in SEPHMI or SEPCE App, GSIP, GEPICS, and GPM&C.
- **Hardware** = I/O Module, Light Stack, and Bypass/Release Key, Andon.



SEP/EPP Overview – Action Types: LTC

Line Tracking Console

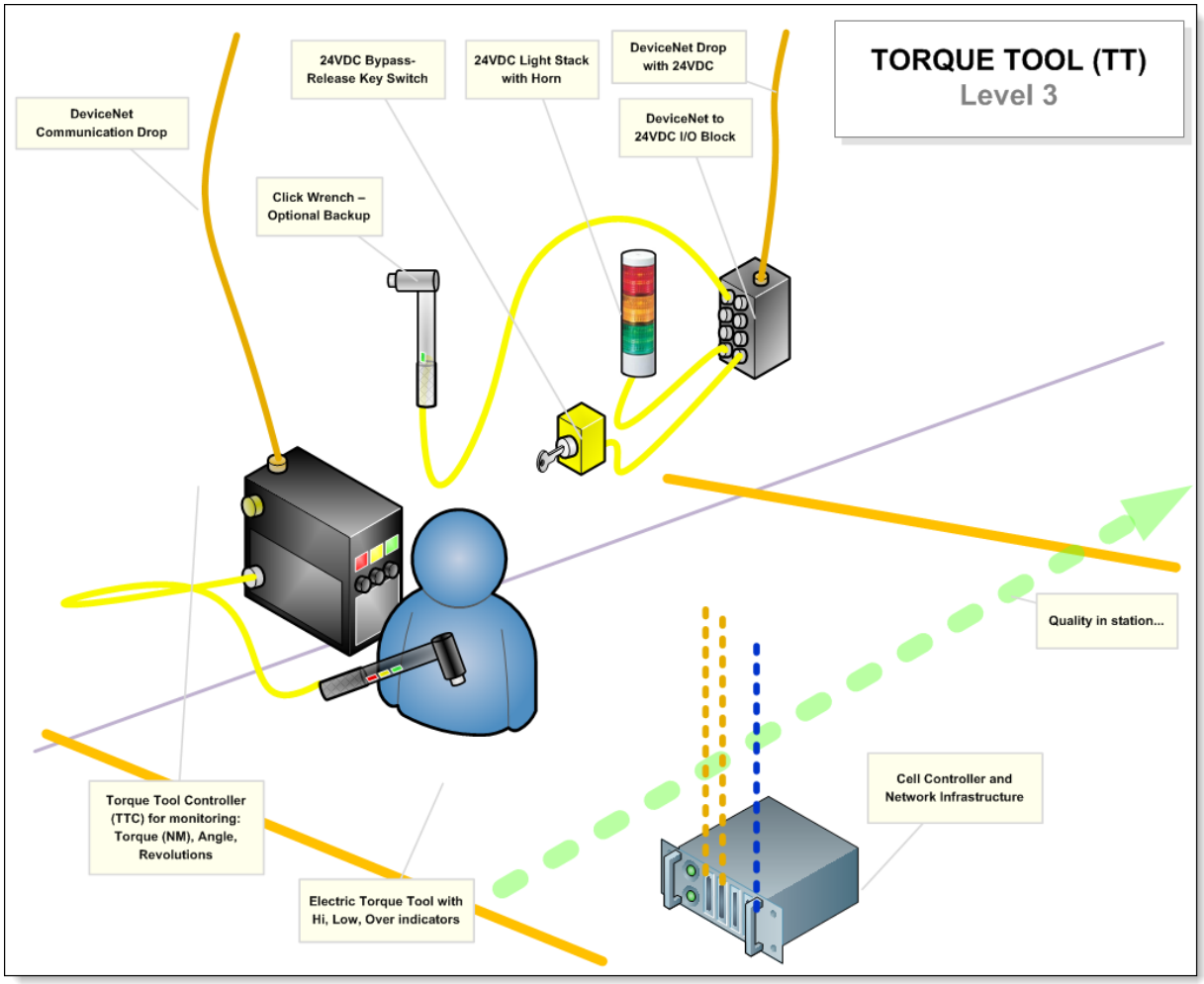
- **Software** = Scanner (**SCN**) Configuration.
- **Hardware** = CE Station, Job Detect, Carrier Detect, Scanner(s).



SEP/EPP Overview – Action Types: TT

Torque Tool

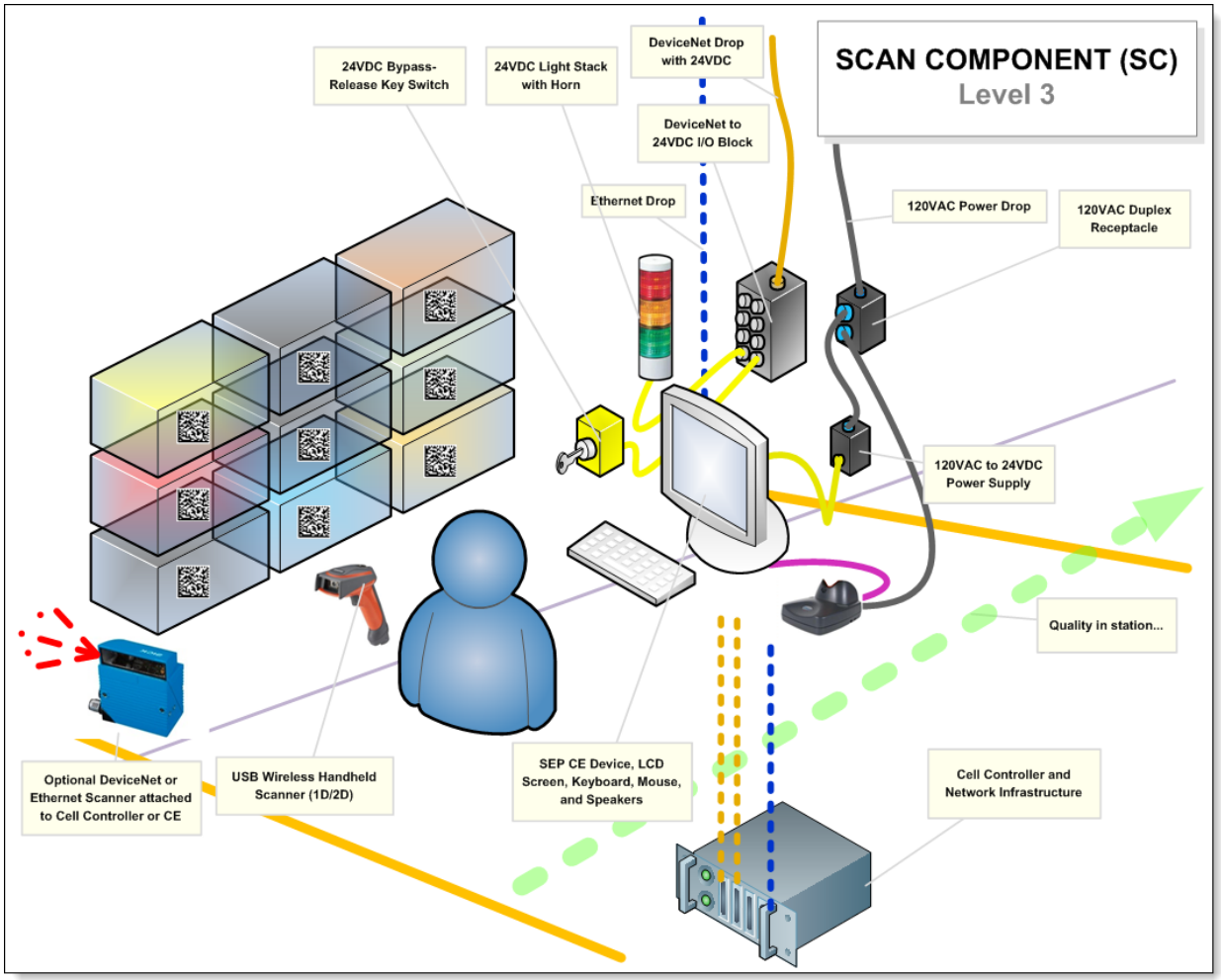
- **Software** = Torque Tool Controller (**TTC**) Configuration.
- **Hardware** = TTC, optional Click Wrenches (**CWR**).



SEP/EPPOverview – Action Types: SC

Scan Component

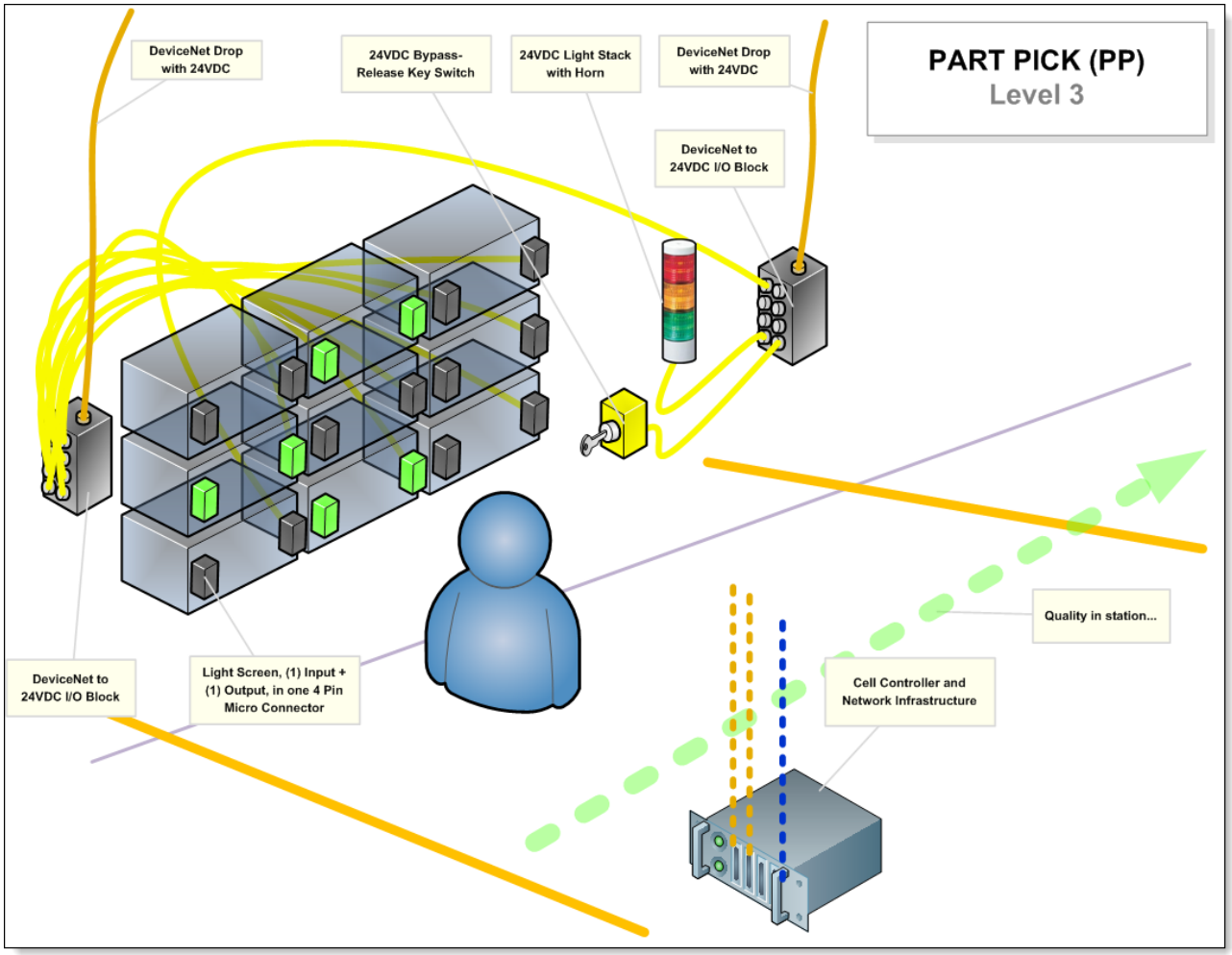
- **Software** = Scanner (**SCN**) Configuration.
- **Hardware** = CE Station, Scanner(s).



SEP/EPPOverview – Action Types: PP

Part Pick

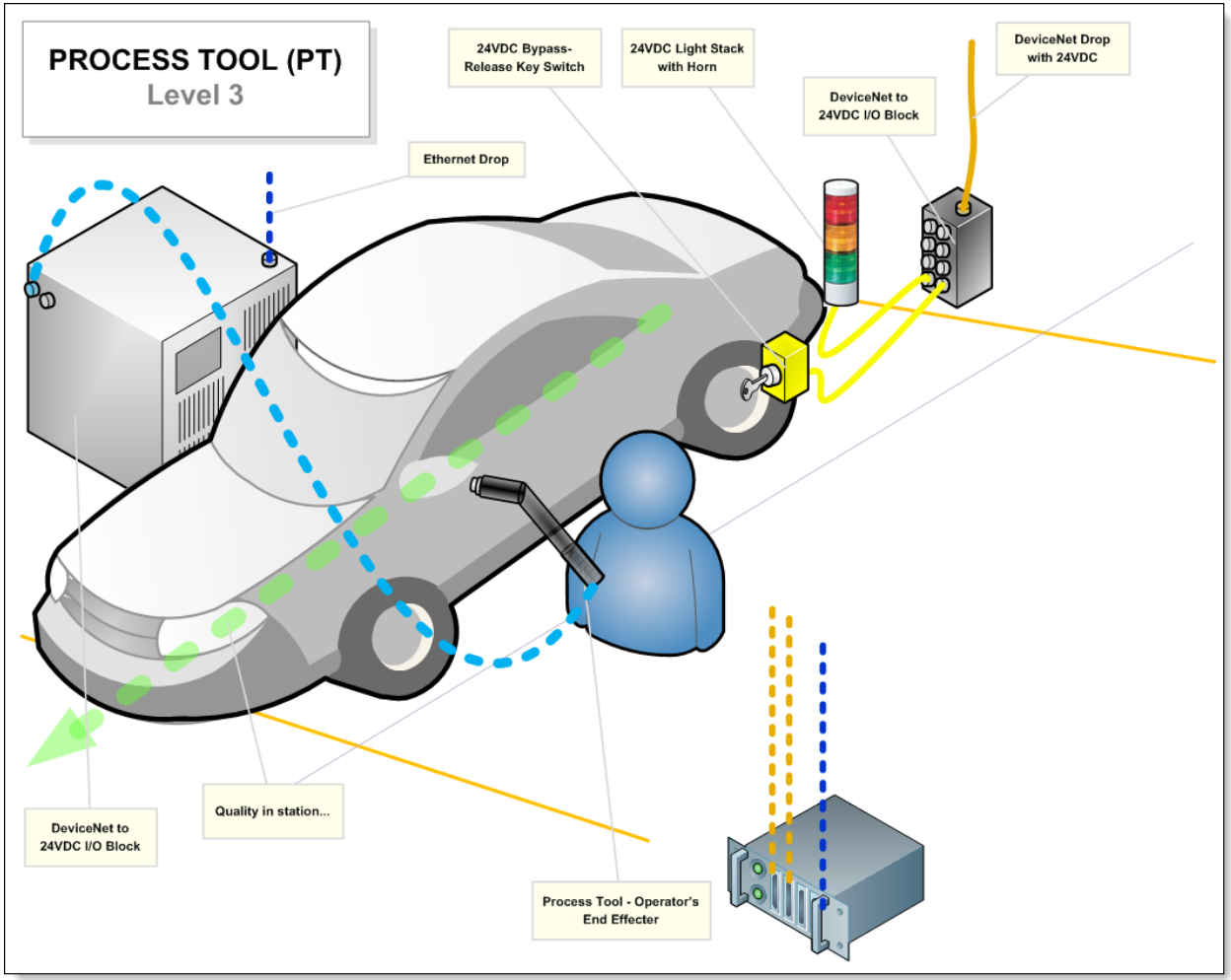
- **Software** = Sensor Configuration.
- **Hardware** = Sensor(s).



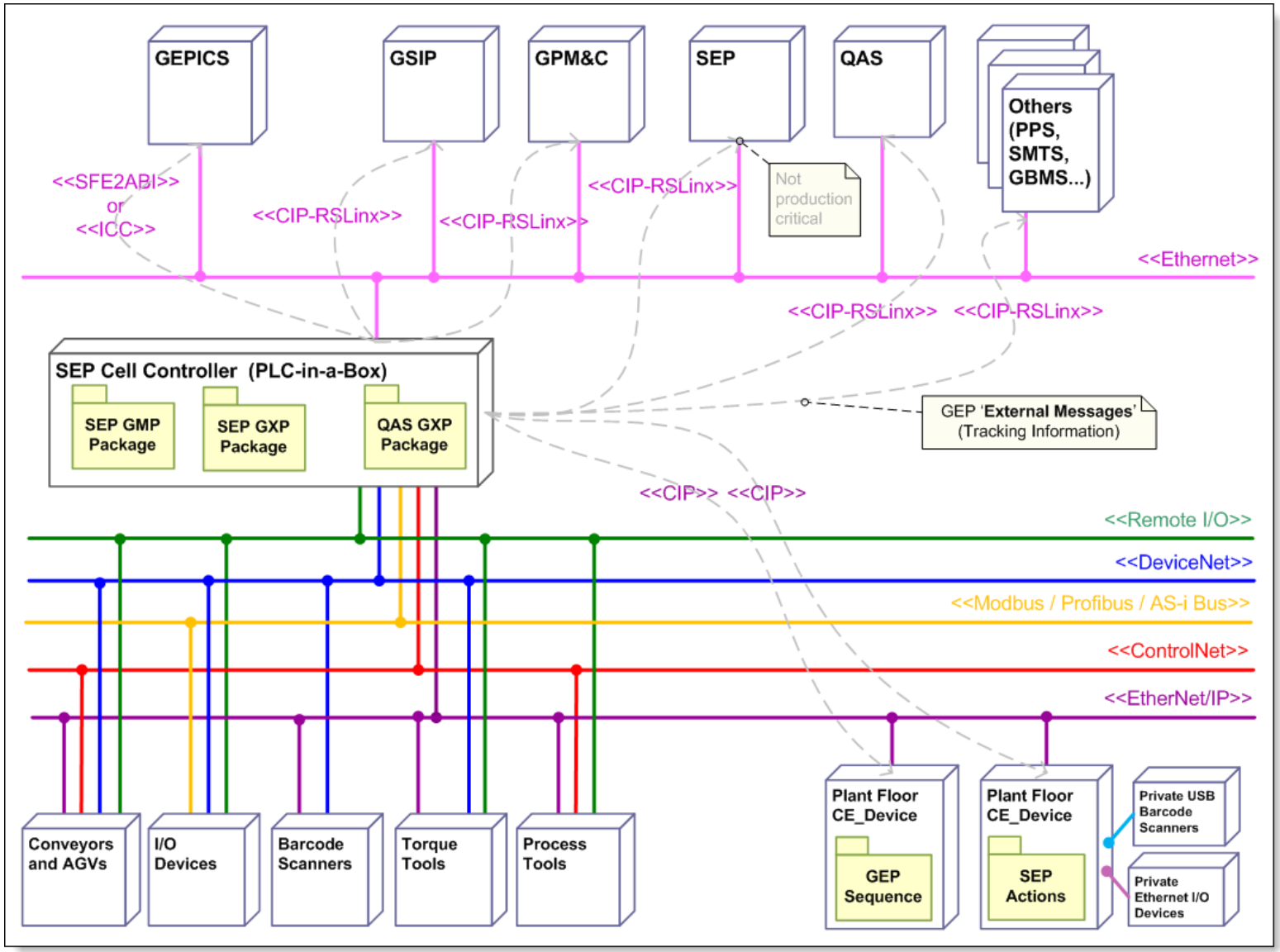
SEP/EPPOverview – Action Types: PT

Process Tool

- **Software** = Process Tool Driver Install & Configuration.
- **Hardware** = Process Tool PLC.



SEP/EPPOverview – Summary



Deployment Overview

Overview of the planning, configuration, installation, and testing of all this equipment…

- **WITS** – Workstation Installation Tracking Sheet
- **ETS** – EPA Tracking Sheet (was Excel, now an Access Database)
- **CFG** – Configuration of SEP/EPP, GSIP, GEPICS, QAS
- **HW** – Installation of all Hardware
- **SAT** – System Acceptance Test
- **UAT** – User Acceptance Test

SEP/EPP Standardized Work

- **WITS** (the latest) → **ETS** -- ALL DATA, ADDs, DELETEs, RELOCATEs, MODIFIES, with Modification Tag in the History Tab.
- **SCRUBs** (the latest) → **ETS** -- ALL DATA, ADDs, DELETEs, RELOCATEs, MODIFIES, with Modification Tag in the History Tab.
- **ETS** → **SEP/EPPSQL Database** – 1) ADDs, 2) RELOCATEs, 3) DELETEs, 4) MODIFIES… in this order whenever possible.
- **SEP/EPP SQL** → Deployment Sheets (**DPS**) into the field as soon the area has installation or re-install in process.
- **SEP/EPP SQL** (or ETS for CEs) → **TAGs** after hardware install is complete and is 'SAT Ready'
- **SATs**

Please follow this process so that the ETS always represents the complete picture of what you are going to do to any Area of the Plant before you start editing the SEP/EPP SQL Database.

Deployment – WITS

Workstation Installation Tracking Sheet…

- **Excel Spreadsheet → now Access Database**
- **Collection of Information** from Industrial Engineers (IEs), Manufacturing Engineers (MEs), VS Assembly Engineers, etc.

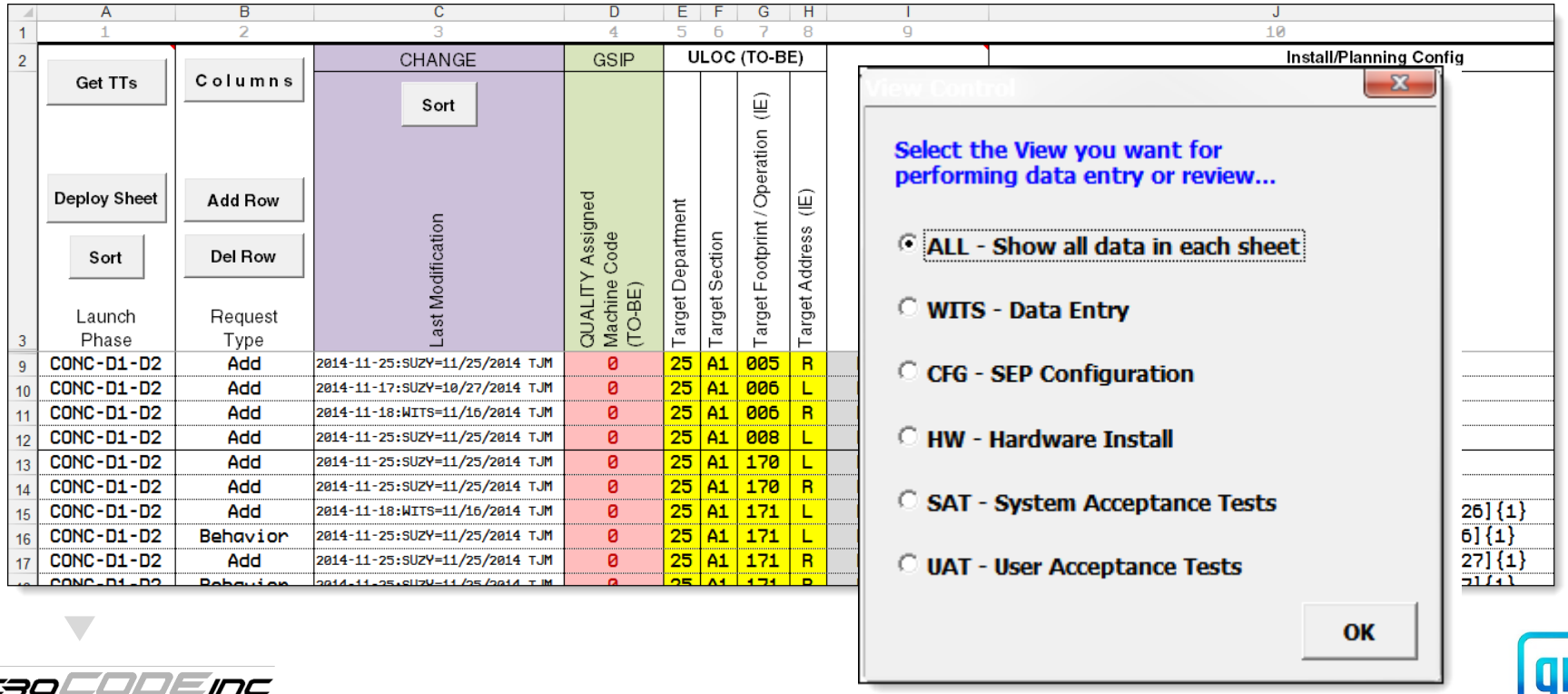
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	**Workstation Installation Tracking Sheet (WITS)**										**Plant: LORDSTOWN**		
2	**Station Information**						**Item Information**						
3	**Sort No.**	**Item No.**	**AREA**	**Work Type**	**Current Location**	**New Location**	**Item Category**	**SEP EPA Type**	**Disable Line Stop?**	**Item Description**	**SOR Section**	**PAD Description Part Noun Name(s)**	**MP**
37			IP	NEW		17-IP-007L	TORQUE CONTROLLER / STAND			TORQUE MONITOR WITH STAND			
38			IP	NEW		17-IP-007L	ERROR PROOFING	SC - Scan Trace Data		ADD STEERING COLUMN SCANNER TETHERED ON BALANCER			
39			IP			17-IP-007R	OPEN			OPEN			
40			IP			17-IP-008L				KPC CHECK			
41			IP			17-IP-008R				NON-WORKABLE			
42			IP			17-IP-009L				AIR DUCT			
43			IP	NEW		17-IP-009L	LMS CART			ADD LEFT SIDE AIR DUCT, RIGHT SIDE AIR DUCT, AND HORSE COLLAR & ADD HVAC HOSE			
44			IP	NEW		17-IP-009L	SINGLE SPINDLE AIR			ADD SSA-509 TO SECURE RT HAND AIR DUCT BOLT		BOLT/SCREW - FLR FRT AIR OTLT DUCT	5491
45			IP			17-IP-009L	TRAVEL TRAY			TRAVEL TRAY			
46			IP			17-IP-009R				NON-WORKABLE			
47			IP			17-IP-010L				RETAINER #1 & #3			

Deployment – ETS

EPA Tracking Sheet…

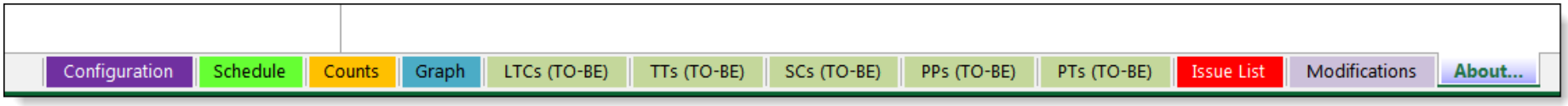
- **Excel Spreadsheet**

- **Extraction of Information** from the WITS
- **Hardware Configuration** from SEPHMI
- **GSIP Machine Codes** from Plant Quality Department



Deployment – ETS

EPA Tracking Sheet…

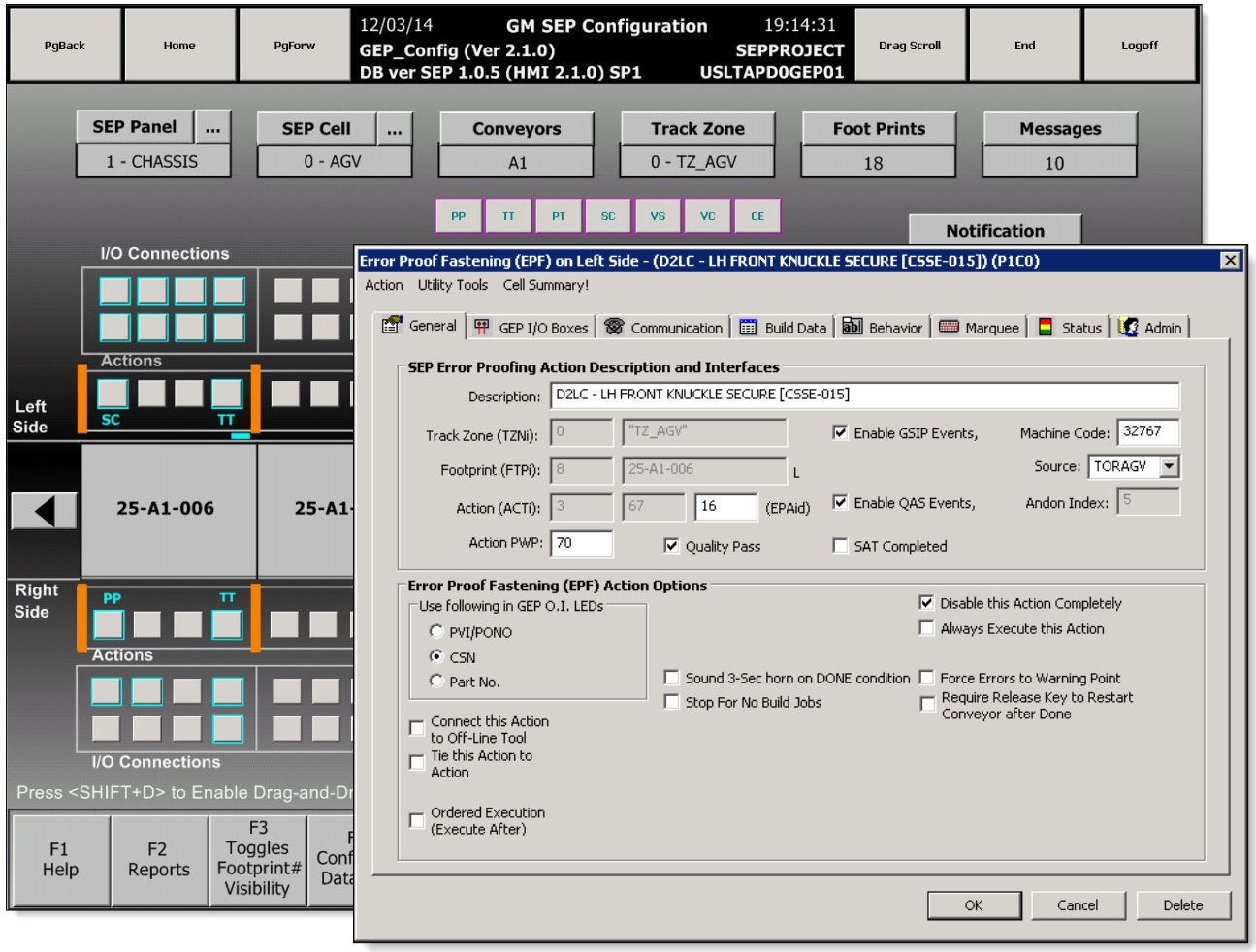


- **Configuration** controls what the ETS is being used for
- **Schedule** gives a status report and automatically schedules SATs
- **Counts** shows quantities of each EPA
- **Graph** shows chart of current deployment status
- **TO-BE** tabs are used to gather information and keep track of progress
- **Issues List** for SEP/EPPrelated deployment issues
- **Modifications** is a coded history of where the information in the ETS came from, and acts as a pull-down menu
- **About** has history of ETS and commands for controlling its use

Deployment – CFG

SEP/EPP HMI/UI Configuration Mode…

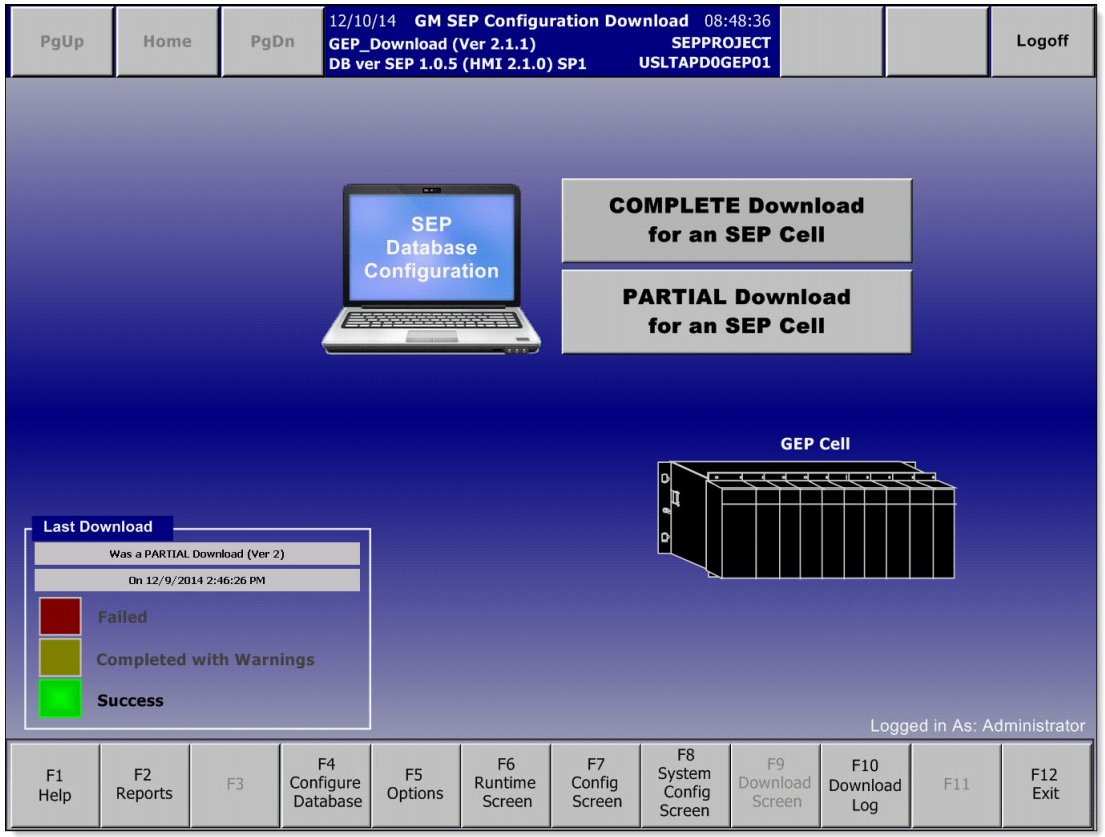
- **I/O Connections** – the hardware being used by the EPAs
- **Actions** – the EPAs themselves



Deployment – CFG

SEP/EPPHMI Configuration Download…

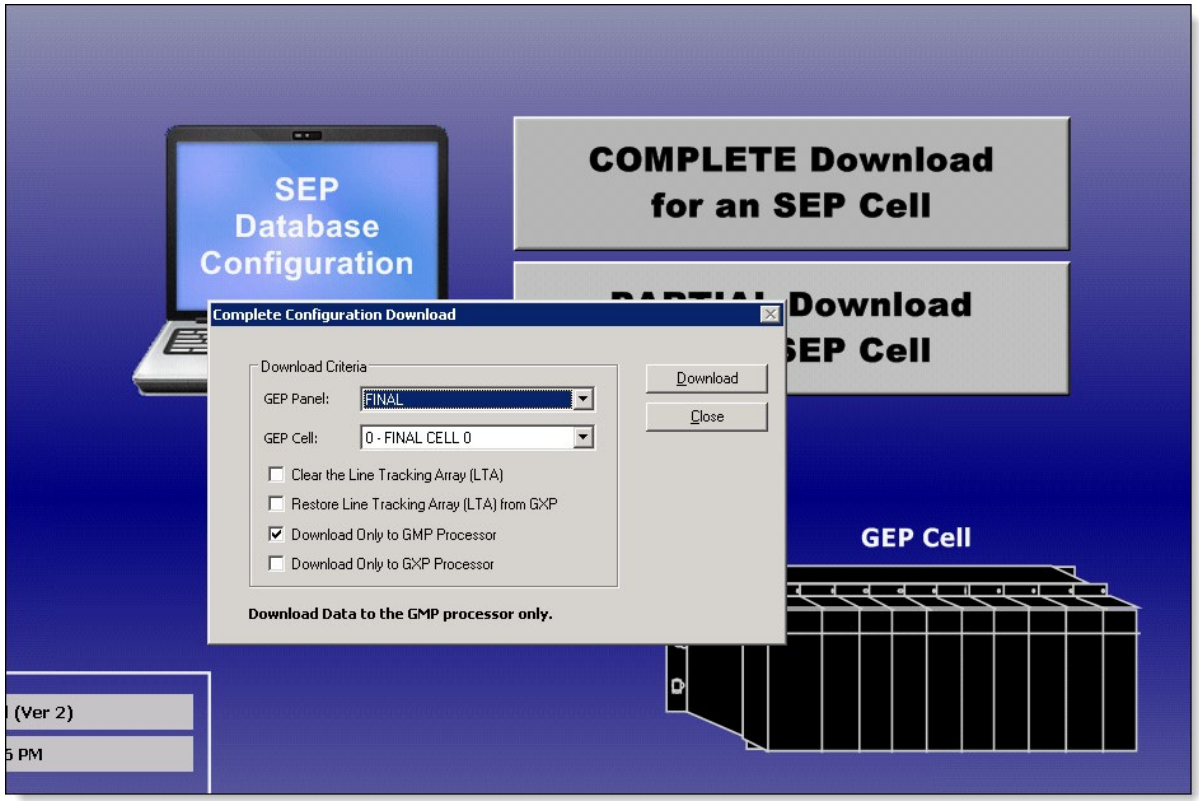
- **COMPLETE** – often called a ‘FULL’ Download, complete replacement of all configuration data in the Cell Controller PLC(s)
- **PARTIAL** – an update of the existing PLC configuration with changes since the last COMPLETE Download



Deployment – CFG

SEP/EPPHMI COMPLETE Download…

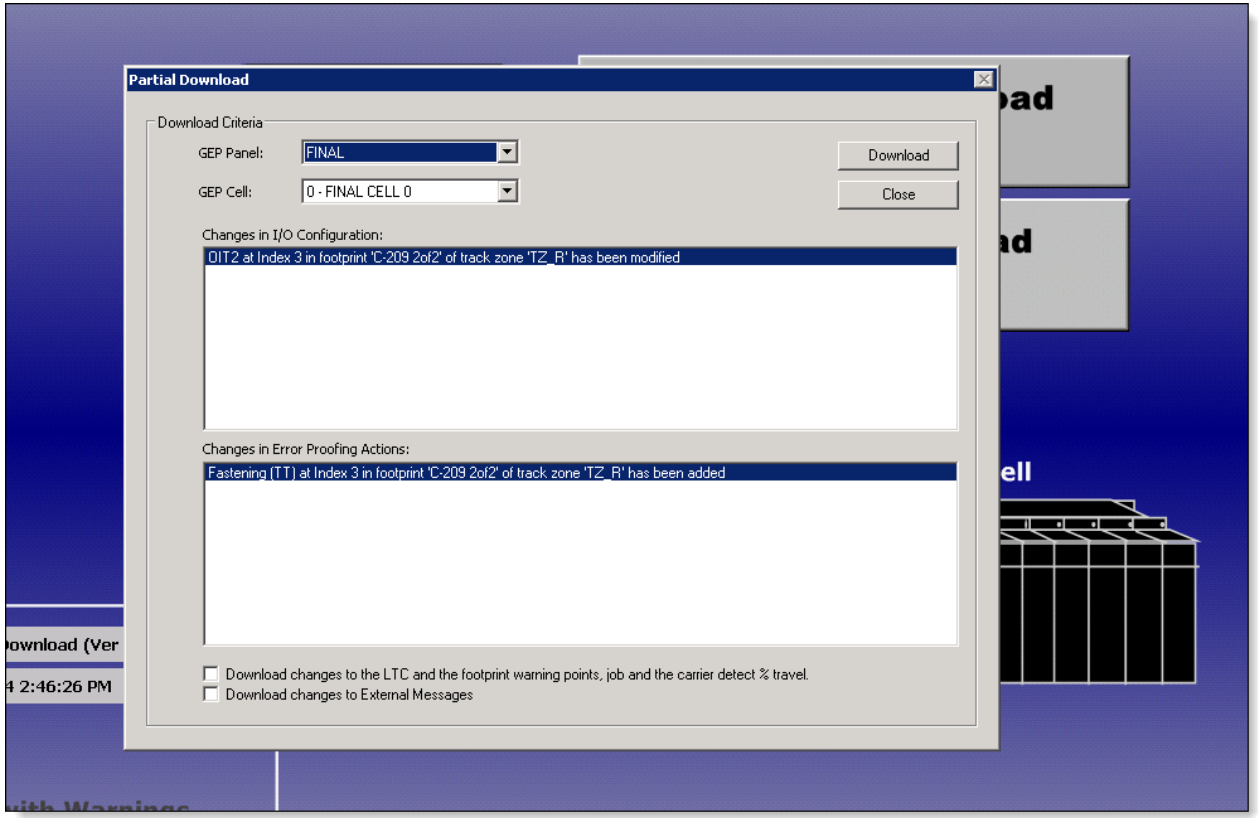
- **COMPLETE Download** – can only be performed when no Conveyor is running, i.e.: Non-Production time, Lunch, Break, or between Shifts.
- **Takes 15 – 25 minutes** and must be completed before the Plant can run again.



Deployment – CFG

SEP/EPPHMI PARTIAL Download…

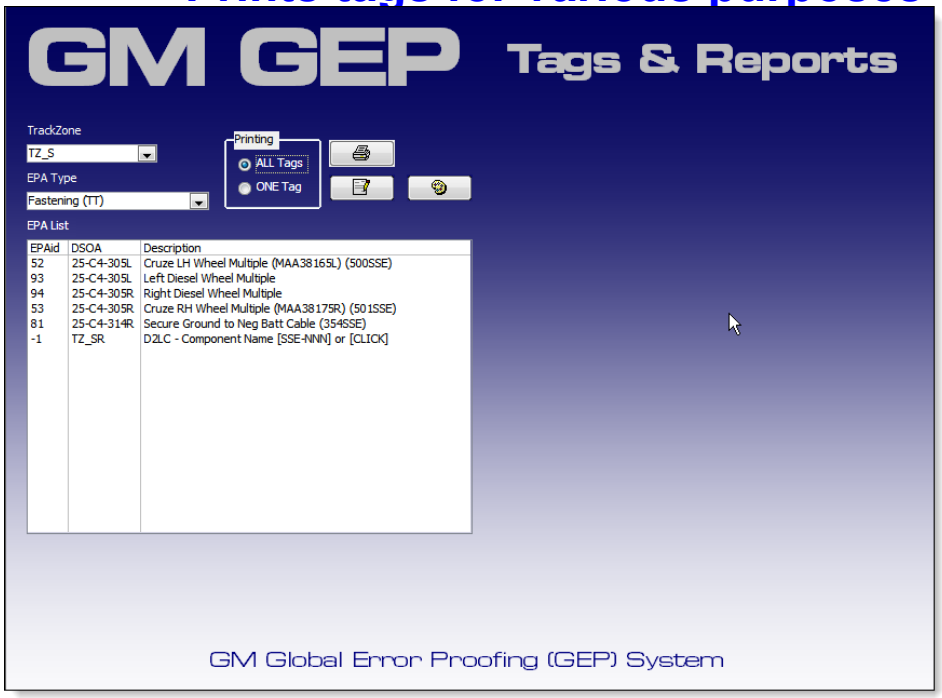
- **PARTIAL Download** – can be performed at any time, **should** be performed in coordination with Production between Jobs.
- Time taken is based on the number of changes being downloaded, changes only effect the objects being updated.

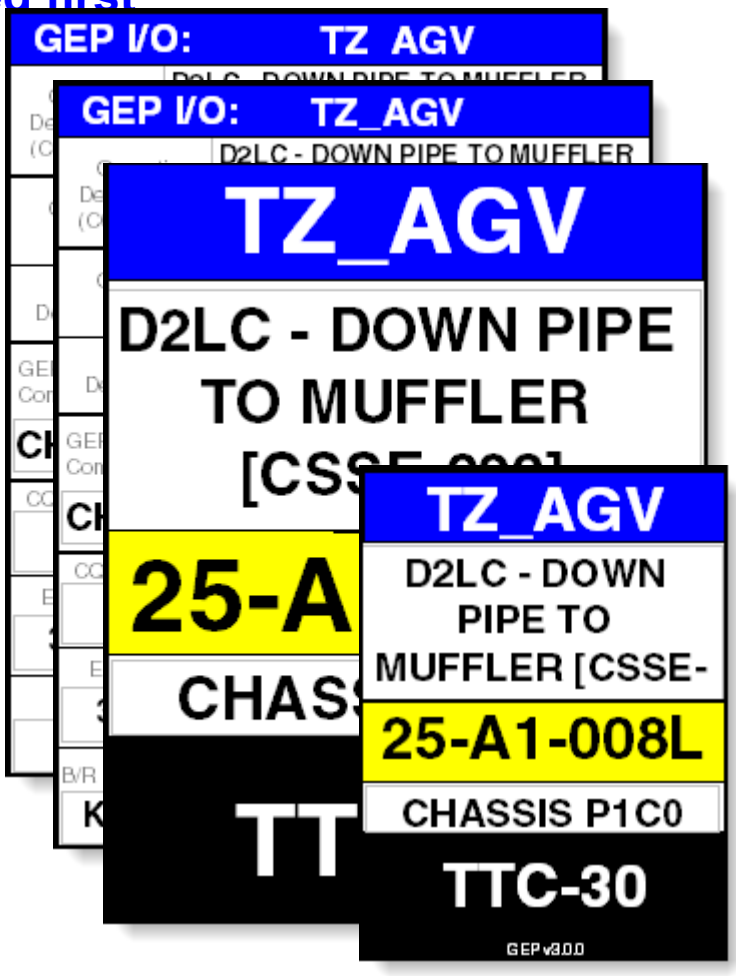


Deployment – CFG

SEP/EPPTagging Microsoft Access Tool: **GMGEP TAGs & SAT Forms.mdb**

- **Connects to SEP/EPPServer SQL Database**
- **I/O and Actions must be configured first**
- **Prints tags for various purposes**

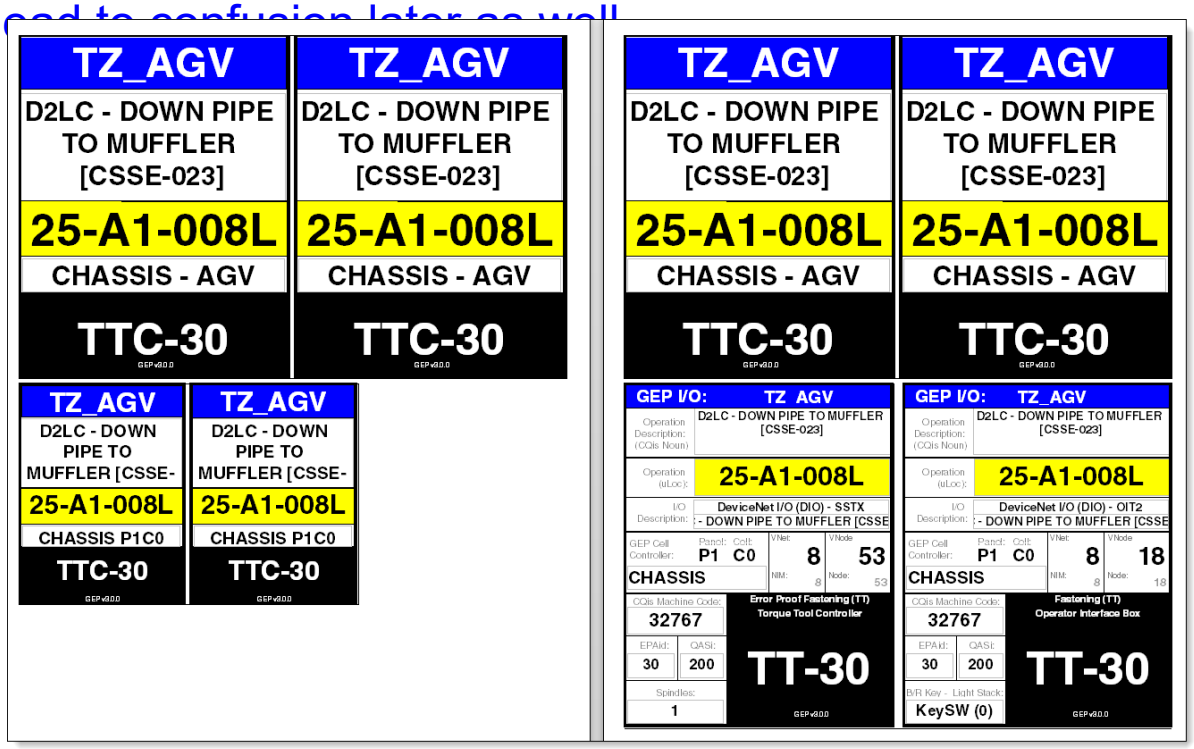




Deployment – CFG

SEP/EPP Tagging Microsoft Access Tool: **GMGEP TAGs & SAT Forms.mdb**

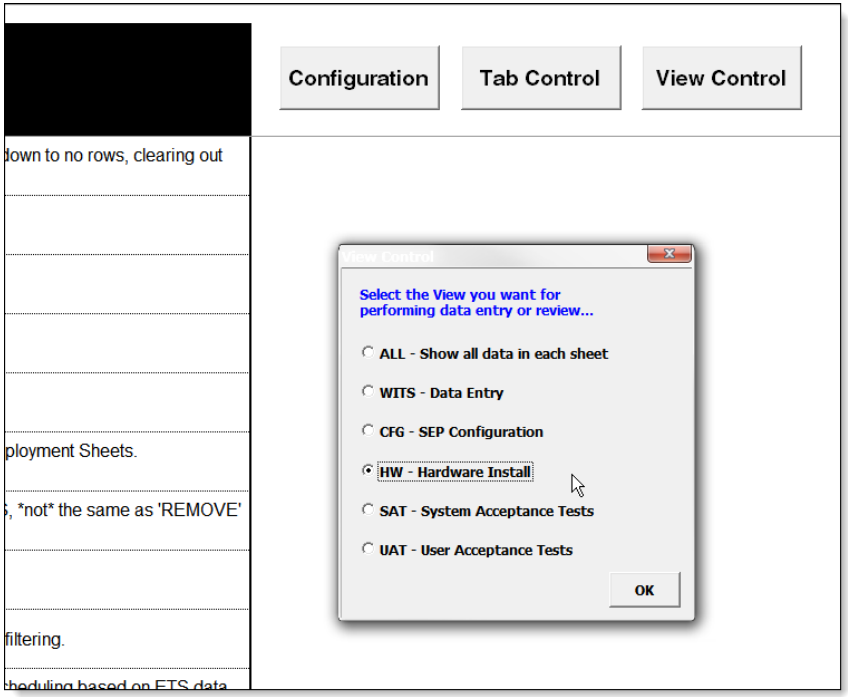
- **Rule #1:** All I/O Devices must be Tagged
- **Rule #2:** Light Stack and Keyswitch are only tagged if the are not mounted directly to the I/O Module 'Blue' Plate
- **Rule #3:** Use common sense, don't waste time hanging redundant Tags, these lead to confusion later as well



Deployment – HW

Hardware Installation…

- Performed by **Plant Skilled Trades** or **Outside Contractors**
- **Single EPAs** – can be installed between Shifts, on Weekends, or even during Lunch Breaks.
- **Network Changes** should only be done on Weekends or during Shutdown periods



Deployment – HW

Hardware Installation…

- Deployment Sheets to aid in hardware install
- **Provides a sanity check for the hardware installer**
- **Provides I/O addresses for hardware installer**

Torque Tool - Deployment Sheet

TO-BE Description:	RH STABILZER SHAFT AT STRUT
AS-IS Description:	D2LC - RH STABILZER SHAFT AT STRUT
Tool Number, Spindles:	CSSE-145 , 1
PSETs, Rundowns:	1 , 1
TTC TCP/IP Address:	120.27.255.98
Request Type:	Add
Current Status:	CONFIGURED

	TO-BE	AS-IS
GSIP Machine Code:	31091	31091
Track Zone:	Y	TZ_R
DSOA:	25-C2-205R	25-C2-205R
O.I. Node Light Stack + Key	**O.I.**	**O.I.**
Network No.	14	14
Node No.	12	12
Torque Tool Controller	**TTC**	**TTC**
Network No.	14	14
Node No.	52	52
Click Wrenches	**CWR**	**CWR**
Network No.		
Node No.		

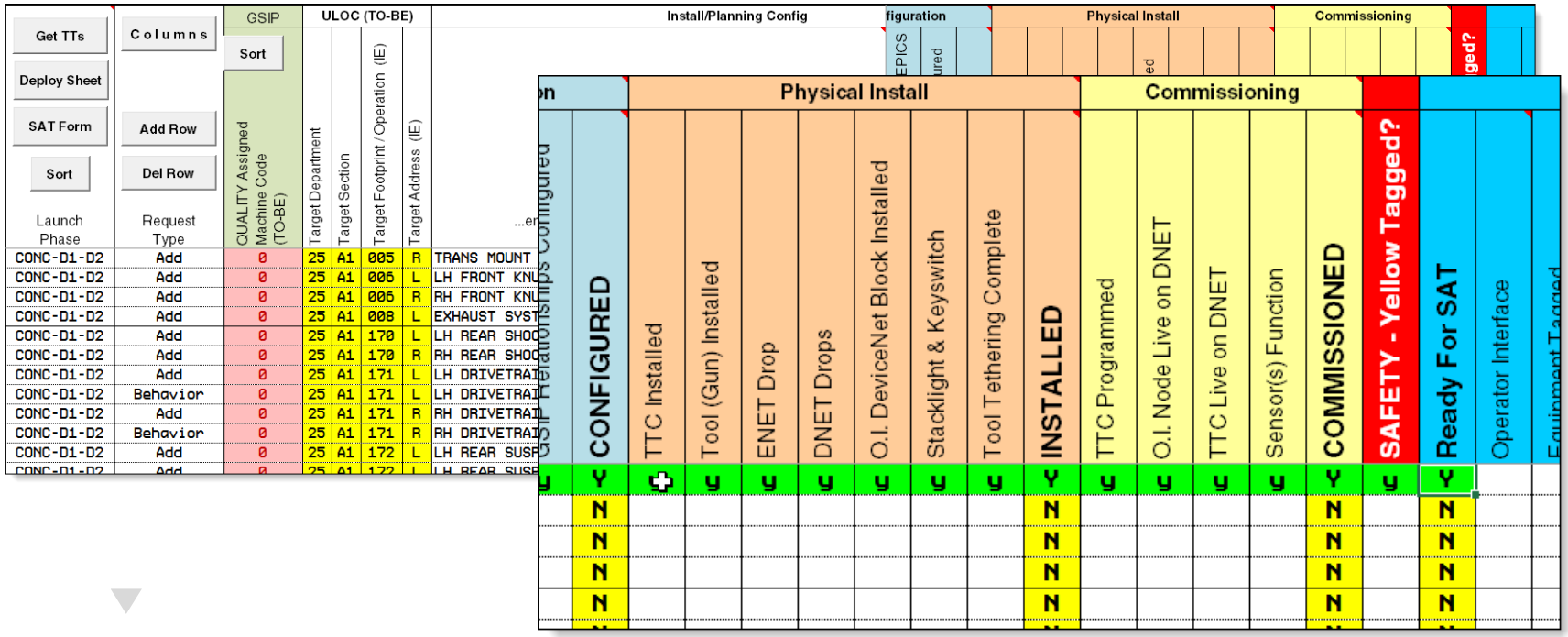
NOTES:
Double Stand location.

INSTALL Instructions:
Use a single Light Stack on the I/O Block, not shared with other TT in this Footprint.

Deployment – HW

Hardware Installation…

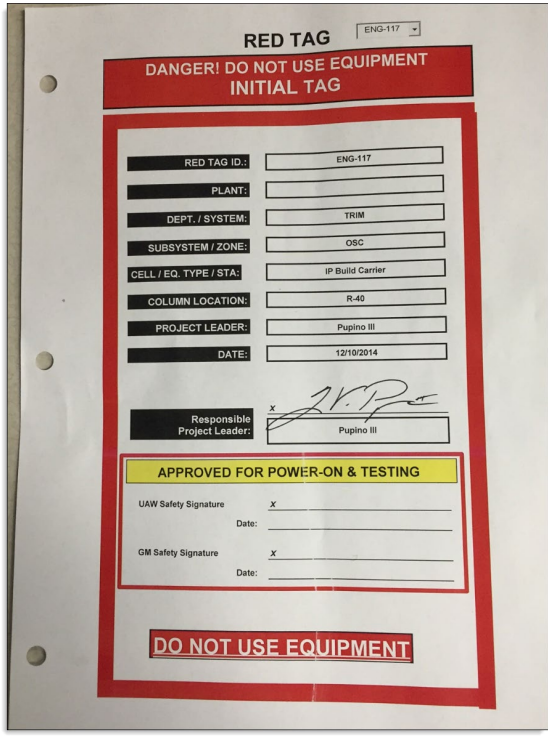
- **ETS Checklist** – used to record hardware status
- **Physical Install** – Stand, Tool, I/O Nodes, Network Drops
- **Commissioning** – Node Addressing, Network Configuration

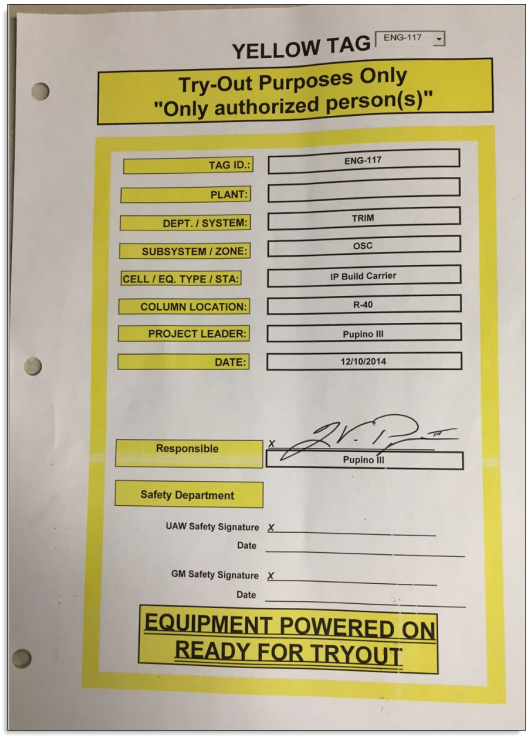


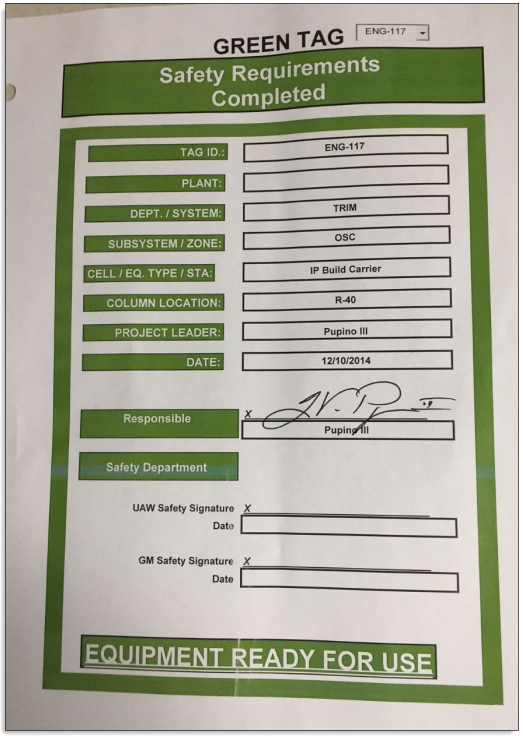
Deployment – SAT

System Acceptance Test (SAT)…

- **Prerequisites** – Hardware Installation and Commissioning is complete
- **Equipment must be YELLOW TAGGED** by Safety



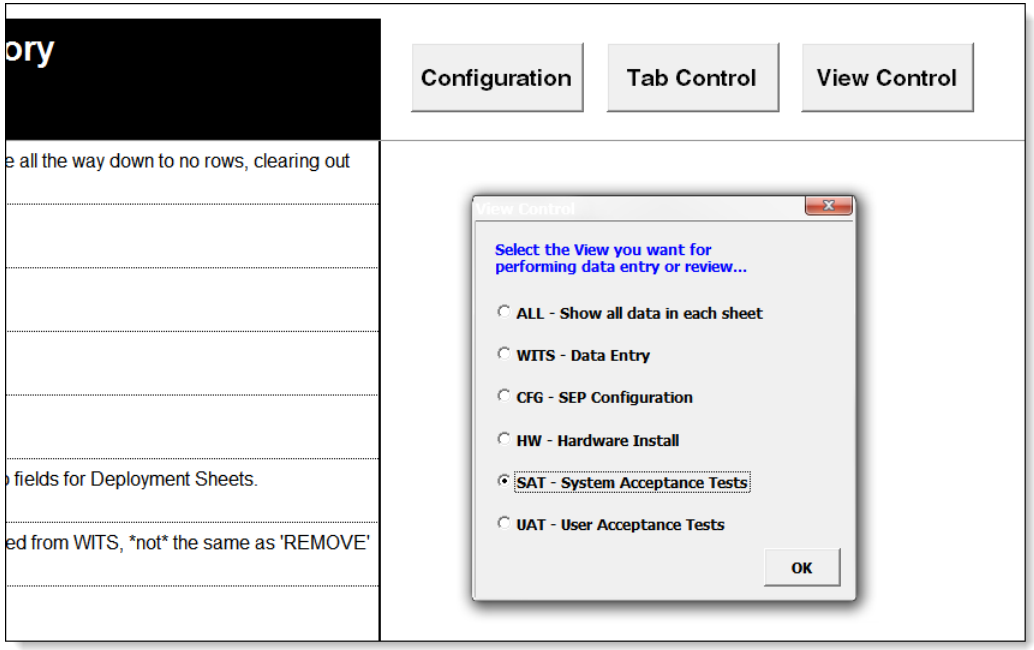




Deployment – SAT

System Acceptance Test (SAT)…

- **Performed by SEP/EPP Team** – GM Engineering and/or outside Contractors
- **Single EPAs** – normally handled by Plant Engineering
- **Major Product Programs** – handled by Project Launch Team and handed off to Plant Production and Plant Engineering during UATs



Deployment – SAT

System Acceptance Test (SAT)…

- **ETS Checklist** – used to record SAT status
- **Functionality –** "We know this EPA is ready for Production, Plant… perform your User Acceptance Test (UAT) so you agree."

Get TTs | Columns | Deploy Sheet | SAT Form | Add Row | Sort | Del Row

TTs

Launch Phase	Request Type	GSIP: QUALITY Assigned Machine Code (TO-BE)	ULOC (TO-BE): Target Department	Target Section	Target Footprint / Operation (IE)	Target Address (IE)	STATUS	Install/Planning Config: DESCRIPTION (TO-BE) PAD PART NOUN NAME ...end with [TOOL-NUMBER] {ROUNDOWNS} e.g. [SSE-112]	RUNDOWNS	figuraical Imissic: CONFIGURED	INSTALLED	COMMISSIONED	SAT: Ready For SAT	Operator Interface	Equipment Tagged	GEPICS Build Data	TTC responds to New Job in FP	QAS Configuration	GPM&C DTR Alarms	SAT Complete	UAT: UAT Ready	UAT Complete	Local File Storage
CONC-D1-D2	Add	0	25	A1	005	R	Ready For SAT	TRANS MOUNT STRUT [CSSE-017]{1}	1	Y	Y	Y	Y							N	N	N	
CONC-D1-D2	Add	0	25	A1	006	L	REQUESTED	LH FRONT KNUCKLE SECURE [CSSE-015]{1}	1	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	006	R	REQUESTED	RH FRONT KNUCKLE SECURE [CSSE-016]{1}	1	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	008	L	REQUESTED	EXHAUST SYSTEM INTER [CSSE-023]{3}	3	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	170	L	REQUESTED	LH REAR SHOCK TO BODY [CSSE-024]{1}	1	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	170	R	REQUESTED	RH REAR SHOCK TO BODY [CSSE-025]{1}	1	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	171	L	REQUESTED	LH DRIVETRAIN & FRT SUSP C/MBR FRT [CSSE-026]{1}	1	N	N	N	N							N	N	N	
CONC-D1-D2	Behavior	0	25	A1	171	L	REQUESTED	LH DRIVETRAIN & FRT SUSP C/MBR RR [CSSE-026]{1}	1	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	171	R	REQUESTED	RH DRIVETRAIN & FRT SUSP C/MBR FRT [CSSE-027]{1}	1	N	N	N	N							N	N	N	
CONC-D1-D2	Behavior	0	25	A1	171	R	REQUESTED	RH DRIVETRAIN & FRT SUSP C/MBR RR [CSSE-027]{1}	1	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	172	L	REQUESTED	LH REAR SUSPENSION AXLE [CSSE-028]{3}	3	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	172	L	REQUESTED	LH REAR SUSPENSION EQUALIZER [CSSE-111]{1}	1	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	172	R	REQUESTED	RH REAR SUSPENSION AXLE [CSSE-029]{3}	3	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	172	R	REQUESTED	RH REAR SUSPENSION EQUALIZER [CSSE-112]{1}	1	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	174	L	REQUESTED	LH SHOCK TOWER OUTBOARD TRANS MOUNT [CSSE-030]{3}	3	N	N	N	N							N	N	N	
CONC-D1-D2	Add	0	25	A1	174	R	REQUESTED	RH SHOCK TOWER OUTBOARD TRANS MOUNT [CSSE-031]{3}	3	N	N	N	N							N	N	N	
CONC-D1-D2	Behavior	31054	25	A1	178	L	REQUESTED	Enterprise Bracket Secure [SSE-090]{2}	2	N	N	N	N							N	N	N	

Deployment – SAT

System Acceptance Test (SAT)…

- **SAT Form** – electronic form is contained with the **ETS**
- **Print Command** – fills out form from selected ETS Row
- **Execute SAT** – fill in Names, use Checkboxes, take Notes, Print result to .PDF file and drop in GEP SHARE Drive