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Design of TAS using PLC and Batch Controller

Sreeraj S[1]

[1]*Software Engineer, ADAS Business Unit, Continental AG, Bangalore, India*

Abstract – *In this paper, the design of sequential process involved in the automation of oil and gas terminals is explained. This paper talks about various levels included in the TAS or Terminal Automation System as subsystems, the different mechanical and electronics equipment used and how they are designed.*

***Key Words*: TAS, Batch Controller Unit (BCU), PLC, SCADA, Digital Control Valve, LOAD RACK COMPUTERS**

1.INTRODUCTION

One of the most relevant economic sectors in India is the petroleum industry. Due to its highly inflammable nature, dealing with both oil and gas is of very high risk. Because of the mistakes and carelessness done by humans, so many deadly accidents have occurred in the oil and gas field. Products which are refined from refineries are stored in places called Terminals. These products are despatched to oil pumps from the terminals only. Many of the petroleum products are highly inflammable and their cost is also very high. So, we require a safe, hazard free, at the same time a commercially successful environment. This is the scenario where automation of the oil and gas terminals is of high importance. Here the automation process of the oil terminals is discussed.

The entire process can be divided into three fields.

- Programmable Logic Controller (PLC)
- SCADA and Control room
- Field devices

All the pipe lines, trucks, tanks, batch controllers, wagons, card readers, radar gauges, sensors, air eliminators, RTDs, valves, strainers etc. comes under field devices.

Control room has the communication devices such as mod buses, servers, PCs, RTUs, switches etc. Signals from the field are received by these devices through RS 232/485 cables. LAN interconnects all the devices in the control room. The processes are remotely controlled from the control room through SCADA.

The PLC will get energised by the control signals which SCADA gives and the PLC will control the field devices. PLCs used in terminal automation are two in types. Safety PLC and the Process PLC. The first one is used for safety applications like ESDs. The second one controls the barrier gates, DBBVs, pumps etc.

2. SUBSYSTEMS OF TAS

The Terminal Automation process starts with the truck enters the terminal and ends with the truck leaving the terminal after the tank compartments are filled with fuel. During this time there are several processes like generation of fan, interfacing SAP with TAS, entering into licensed area, batch controller functioning, loading, cancellation of truck, bypassing, aborting truck etc. All these operations will come under eight main subsystems and they are briefed below.

2.1 TAS-SAP INTERFACE

TAS-SAP interface is developed in a view to automate the transfer of data between server and client TAS system. It has in built control and executable algorithms for its proper working.

2.2 GANTRY AUTOMATION SYSTEM

The heart of TAS is gantry automation system [2]. The transfer of fuel products is mainly controlled by this unit. It consists of batch controller, Overspill Preventing Device Proximity Card reader, Static charge grounding device, Loading Arm position detector, Loading Arm, DCV, Flow meter, Strainer with Air eliminator, Pressure and Temperature transducers and Pulse transmitter.

2.3 BLENDING AND ADDITIVE INJECTION SYSTEM

Selecting the optimal combination of components to produce the final finished product is one of the most critical economic issues for both traders and refiners. Blending is much more complicated than a simple mixing of components. This system will allow to feed different products from a single loading arm and thereby reduces dependency on more than one tank. This helps in flexibility in operation.

2.4 TFMS SUBSYSTEM

The product which is stored in each tank and its level are constantly monitored by TFMS or Tank Farm Management subsystem [2]. It also watches other related information like temperature and density. Tank gauges, tank slide indicators, temperature sensors, communication interfacing units, TFMS software and water bottom sensors are the major

components of this subsystem. Mainly it has all the measuring equipment and the TFMS software to control that.

2.5 TTES SUBSYSTEM

Filling Advisory Note (FAN) generation process is managed by TTES or Tank Truck Entry Subsystem. FAN is generated from the data coming from client to server. Tank Truck Entry System will be provided for authorizing the TT for loading product, for a consignee, by allocating loading bay and to issue access entry card.

2.6 TTRS SUBSYSTEM

All TTs at the locations will be provided with configured RFID tag on the wind screen of the TT as part of Registration requirements. RFID readers will be provided at the entrance of TT Parking area. RIFD reader to read the TT Registration no. of incoming TTs from RIFD tag pasted on the wind screen and convey to Server. Registration number of the TT entering the designated TT parking area will get logged on the Server in S&D automatically and also flashes the same on the Queuing Display Board (QDB) which will be provided in the parking area. Server will communicate with the LRC and SAP.

2.7 CONTROL ROOM SUBSYSTEM

The TAS system is operated and controlled in remote mode in this subsystem. LRCs (Load Rack Computers) which are redundant in nature, printers, PLC, networking devices, panels, UPS units, consoles etc are the main components in this subsystem. LRCs will have the SCADA software installed in it.

2.8 CONTROLLED ACCESS SUBSYSTEM

The entry of trucks and its exit at the terminal is controlled by this subsystem. Barrier gates, traffic lights, RFID readers, , various sensors for identifying vehicle, security station etc are the components of this subsystem.

BCU

The proper functioning of Terminal Automation System is mainly dependant on BCU [1][2]. A Batch Controller Unit (BCU) is a loading system designed for loading gantries of petroleum refineries and oil marketing terminals to control and manage the custody transfer of petrochemical products onto railcars and road tankers. It is a powerful and intelligent loading system, capable of controlling and managing the loading procedure simultaneously via multiple loading arms. The loading system is available in two versions: 1010CJ for straight product loading and 1010CB for MID-compliant integrated loading, blending and addition. It has standard provision for all measurement and control functions for loading/unloading/blending of products such as fuel, biofuels, chemicals, bitumen, asphalt and LPG. This intelligent loading system offers numerous functions, including flow measurement with pulse verification to API and ISO standards, temperature and volume correction and digital valve control.

CARD READER UNIT

The card reader is installed at each bay to restrict the access of unauthorized vehicle / person to a hazardous or nonhazardous harsh area [2]. The card reader is highly safe and so it is being used in areas certified as Zone 0 and any other hazardous area, where there are more chances explosion. It is configured to read cards of different technologies. After the truck is parked inside the bay, the driver has to flash the card at the bay card reader. On flashing card at the bay, the truck appears in the SCADA screen in control room. Upon successful completion of identification, and if card is valid then TAS will check for all safety permissive interlocks.

SCADA SOFTWARE

SCADA controls the whole operation in depot which starts from the arrival of the truck till the exit from the terminal [1][3]. With SCADA one can see the complete loading operation at the gantry area. The graphical representation of the loading process is shown through iVision max software. Details regarding each compartment in a truck such as which compartment is to be filled by which fuel by what quantity, are either given to the device locally or can be given from the SCADA. One can cancel or abort a truck from the SCADA. SCADA energizes PLC to control the field equipment.

DCV

Digital control valve(DCV) is used to limit the product flow as per instructions programmed in Batch Controller. Diaphragm Digital Control Valve is an electrically actuated, hydraulically operated multi-function control valve. It can be used for local as well as remote controlled batching operations with electronic batch controller. When the Diaphragm Digital Control Valve is used with an electronic batch controller, it can be digitally controlled by operating the solenoid valves through any of these three stages.

- when NO and NC solenoids are energized, the valve opens gradually.
- when NC solenoid is de-energized (keeping NO solenoid energized), the valve locks at its current position.
- when NO and NC solenoids are de-energized, the valve closes gradually.

PD - POSITIVE DISPLACEMENT METER

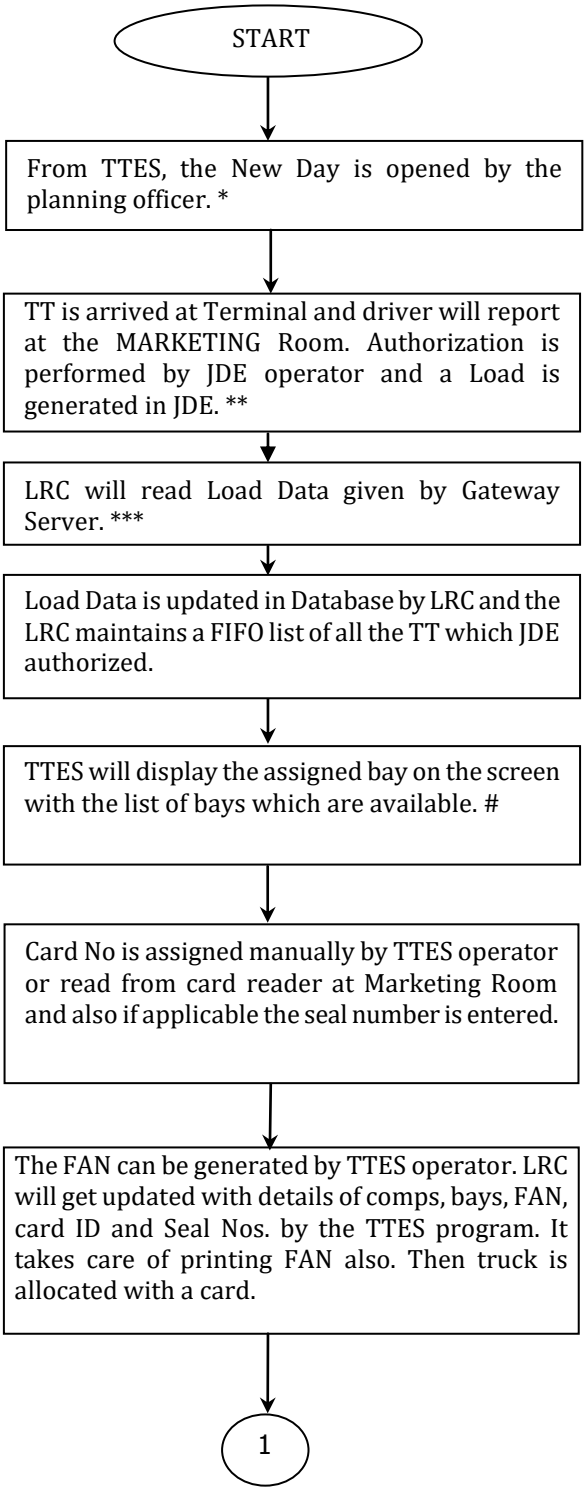
A positive displacement meter is a type of flow meter that requires fluid to mechanically displace components in the meter in order for flow measurement. Positive displacement (PD) flow meters measure the volumetric of a moving fluid or gas by dividing the media into fixed, metered volumes (finite increments or volumes of the fluid). A basic analogy would be holding a bucket below a tap, filling it to a set level, then quickly replacing it with another bucket and timing the rate at which the buckets are filled (or the total number of buckets for the "totalized" flow). With appropriate pressure and temperature compensation, the mass flow rate can be accurately determined.

PLC

PLC controls all the operations involved in the automation process. The logic for the sequential process is either written in functional blocks or in the form of ladder logic. The logic is derived from the functional operation shown in the P&ID diagrams and it is converted in the form of logic gates and the ladder logic is then programmed out of it. PLC programs shall control

- The pump functioning including start and stop from the Operator Interface Console(OIC), Processing demand which the pump raises; sequencing of pumps, controlling the pump locally or remotely etc.
- The opening and closing of control valves from the OIC, control locally or remotely etc.
- Fire Alarm functioning for the entire plant by operating the Fire alarm pumps if fire is spread across the plant.
- PID controllers installed at different areas of the plant as per the configured set point.
- IF any Emergency Shutdown required, PLC will stop the whole plant operations by stopping the pumps which load the product, closing all the Valves, Opening the Barrier gates, stopping all BCUs etc.
- Process the analog data such as signals from Density meter, Pressure transmitter, product level in tanks and temperature signals to pipeline division.

The process of terminal automation system is detailed below in a flow chart. It includes each step that comes in the loading process.

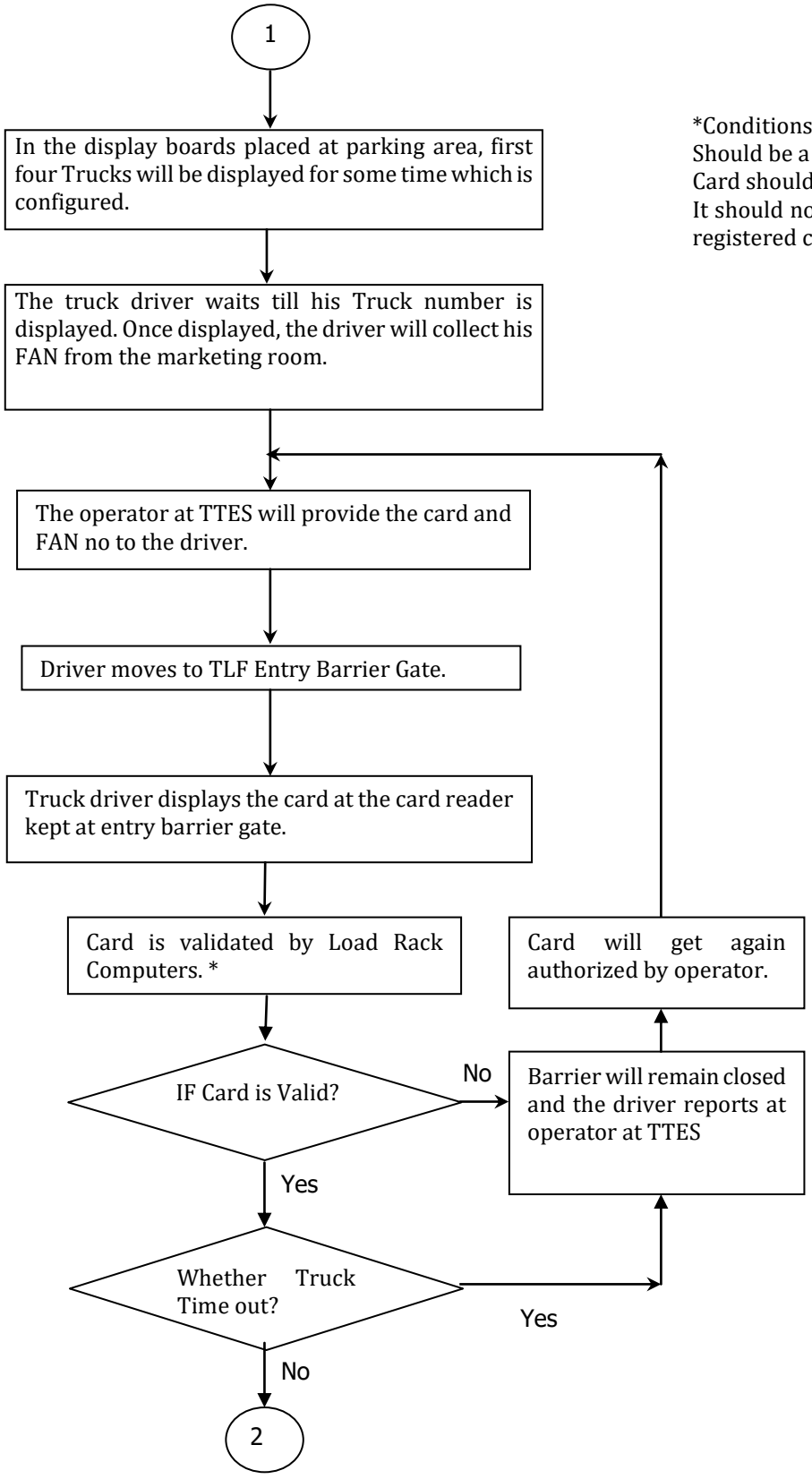


*In a day, Open New Day needs to be done only once.

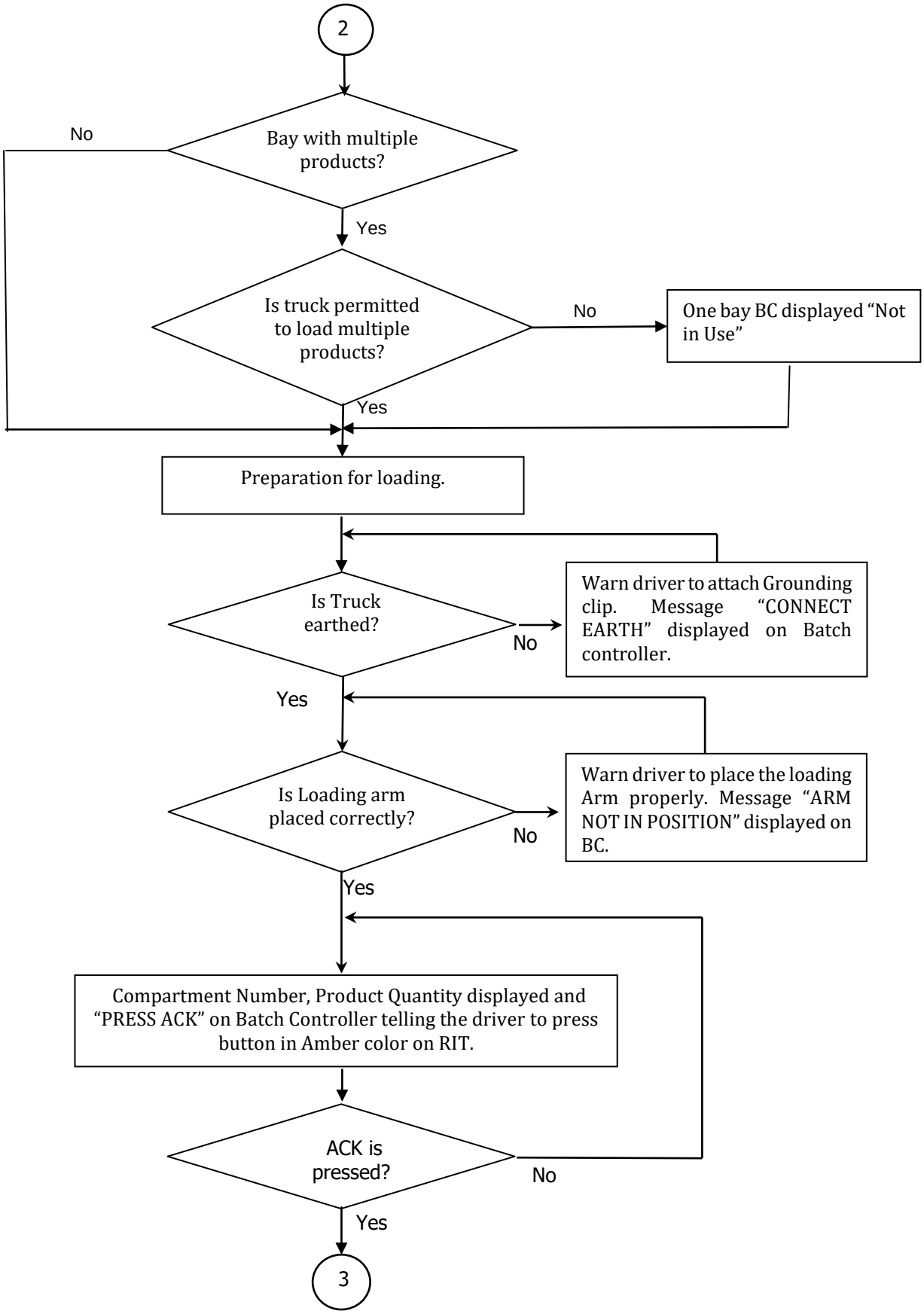
** FAN can get generated from TTES in case SAP system is down.

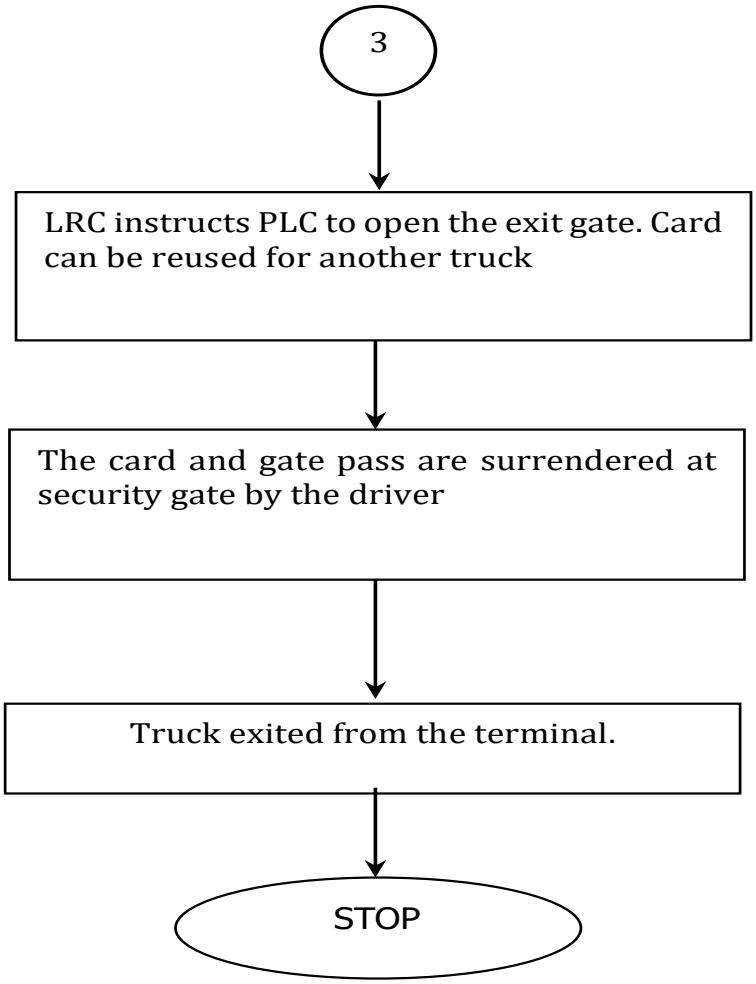
*** JDE will create FAN in manual mode in case LRC is down.

#LRC applies priority system while queuing the Truck for a bay. The truck which is having more priority will be filled first. The other trucks will wait until then.



*Conditions for a card to be valid:
Should be a valid ID,
Card should have a FAN printed.
It should not be an expired card and must be a registered card for loading.


2
Bay with multiple products?
No
Yes
Is truck permitted to load multiple products?
No
One bay BC displayed "Not in Use"
Yes
Preparation for loading.
Is Truck earthed?
No
Warn driver to attach Grounding clip. Message "CONNECT EARTH" displayed on Batch controller.
Yes
Is Loading arm placed correctly?
No
Warn driver to place the loading Arm properly. Message "ARM NOT IN POSITION" displayed on BC.
Yes
Compartment Number, Product Quantity displayed and "PRESS ACK" on Batch Controller telling the driver to press button in Amber color on RIT.
ACK is pressed?
No
Yes
3



3. CONCLUSIONS

In this project, whole process right from the entry of a Tanker Truck into the oil terminal, filling of fuel, its billing, controlling the loading operations, its safety checks till exit from the terminal is designed and implemented with minimum manual interruption.
Benefits of Terminal Automation System are as follows:

- Improves Productivity
- Reduces Loss
- Prevents Accidents & Improves Safety
- Protects the Environment
- Reduces Paperwork
- Expedites Billing Process
- Enhances Product Security
- Terminal Security
- Loading Sequence Control
- Inventory Management
- Stock Balancing
- Order Management
- Transactions Storage

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