LACT Unit

Technical Paper

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Bulletin TP0A016

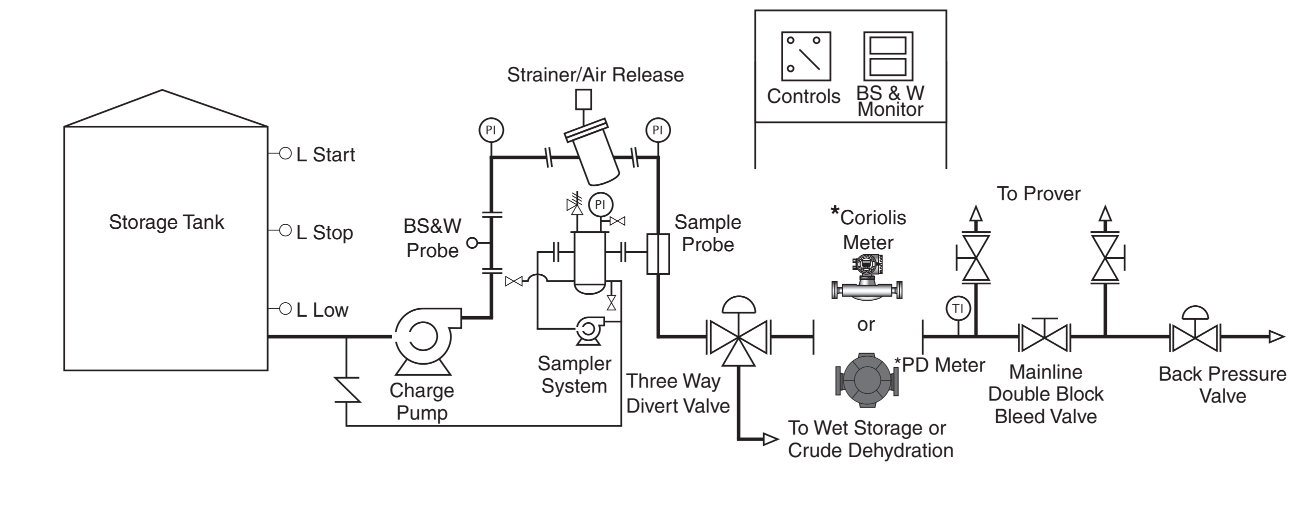

Figure 1.0 – Field LACT typical components.

Introduction

The best method for selling crude oil in Lease gathering operations is by using the Lease Automatic Custody Transfer (LACT) unit.

A LACT unit operates in conjunction to an open feed line to the stock tank, which acts as a surge tank. When oil in the stock tank rises, it will trip a level controller that turns on the LACT unit pump to begin a sales transaction; once the level in the stock tank drops the controller will turn the LACT unit off.

The main objective of a LACT unit is to transfer produced oil to the pipeline. LACT's are used in a number of different applications depending on the field location to a gathering or main pipeline. A field LACT (Figure 1.0) is typically connected directly to a pipeline. The truck or rail LACT (Figure 1.1) could be used to load trucks or rail car tankers at a remote site to transport oil to a pipeline. LACT units may also be used to unload oil vessels to storage for future injection into the pipeline. These are known as Pipeline LACTs or ACT (Figure 1.2), as they are no longer part of the actual Lease Field.

The components on a LACT skid may vary by customer or application. Most will all include the following equipment:

1. Charge Pump – Field LACT's will typically use centrifugal pumps. Unloading sites may use positive displacement pumps.
2. Sampler System
   a. Sample Probe – Located only on the horizontal plane extending into the center of the pipe diameter, in a vertical riser.
   b. Sample Container – Specially designed and installed to prevent vaporization of the stored sample.
   c. Circulating Pump – Allows for complete blending of the sample into a homogenous mixture before and during withdrawal.
3. Strainer/Air Release – Located in a horizontal run of pipe upstream from the meter and at the highest elevation in the system where gases breakout. Other means of air release may be required for unloading applications during start-up and stopping as empty hoses may potentially introduce air into the system.
4. BS&W Probe and Monitor – Mounted in the vertical piping located upstream of the divert valve and meter. The monitor may be remote and is typically adjustable in the range 0-3% in 0.1% increments. Other programmable features may require a flow computer.
5. Divert Valve – If a divert valve is used, it is normally positioned open to the wet oil line to protect against "bad oil" being delivered to pipeline. When the pump is on, the divert valve will only return to "good oil" position when the monitor receives a signal that the BS&W content is at acceptable levels.

6. Meter – The meter selected should be capable of custody transfer accuracy. Meter evaluation should be considered using the information in the Metering Selection Guide on page 5.
7. Prover Valve – Main Line Block Valve should be of the double block and bleed type to ensure all product that has passed through the meter will also pass through the prover. The prover inlet and prover outlet valves should be high quality and sealed downstream with quick couplers, dust caps or blind flanges to prevent leakage or theft.
8. Back Pressure Control Valve – Spring loaded and normally closed. This valve would be only open when BS&W levels are allowing "good oil" flow. Control range depends on maximum expected flow conditions and a 20 psig minimum shut off.

Theory of Operation

Field LACT

Produced oil flows from the surge tank through the LACT unit when the High Level Controller is activated. The High Level Controller activates the charge pump. The divert valve is set to deliver to the "bad oil" line until the BS&W probe is satisfied that acceptable levels of water in oil content have been met. Once the BS&W probe is satisfied, the monitor will divert the three-way

LACT Unit Skid

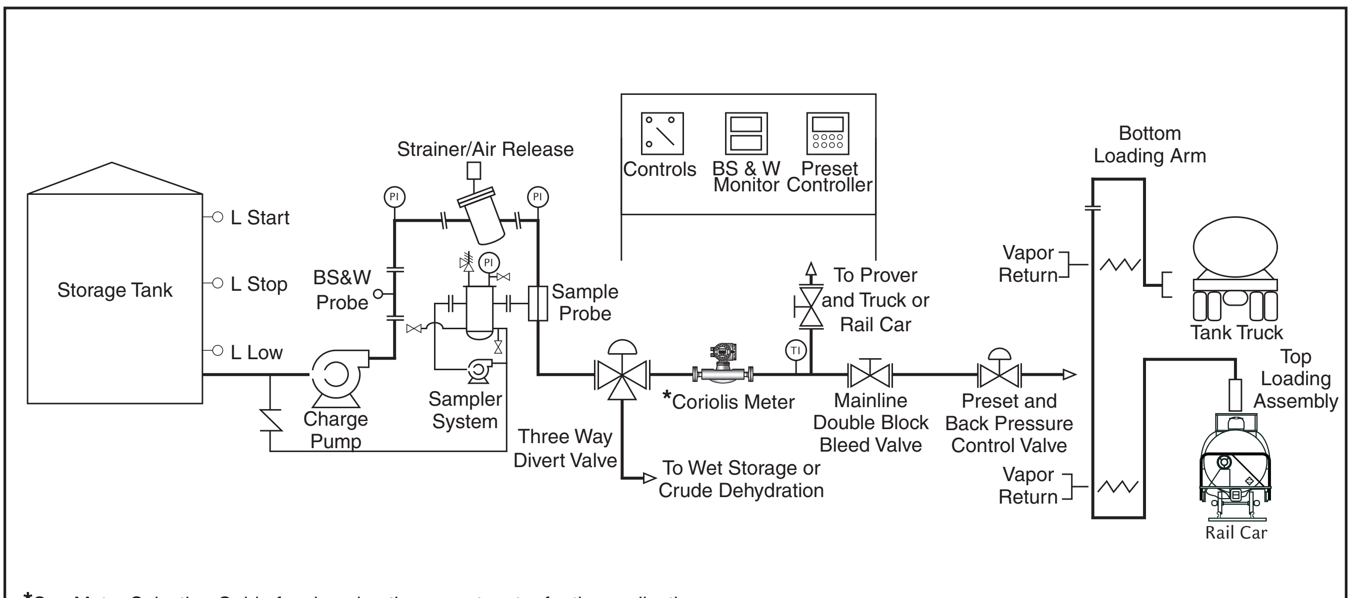

Figure 1.1 – Truck and Rail Loading LACT typical components.

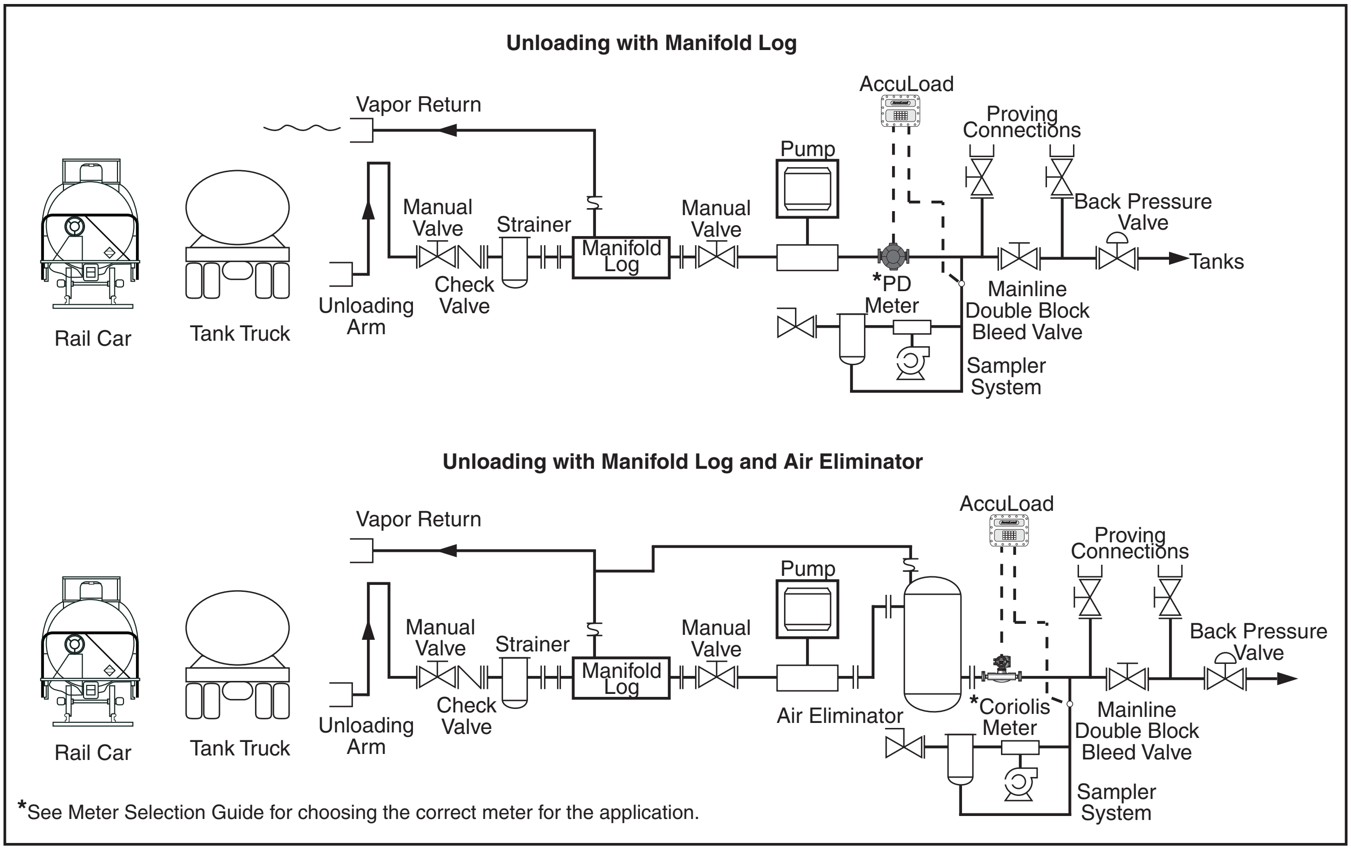

*Figure 1.2 – **Truck and Rail Unloading ACT typical components.***

valve to "good oil" and measurement will begin. As the oil flows, a sample rate and volume is taken to ensure a representative sample of the delivery. As the BS&W probe continues to measure water content, the meter records temperature corrected volume throughout the delivery and the back pressure valve prevents gas break out. If the BS&W content range is exceeded, the divert valve will change to the "bad oil" line until such time the range is once again acceptable. The monitor or flow computer will also record BS&W content. When the Stop Level Controller is activated, the batch is complete and the divert valve is returned to the "bad oil" position. If the Low Level Controller is activated, an optional pump can turn on a visual alarm or pump the water/oil emulsion to a slop tank or treatment facility.

Proving is accomplished by use of a portable prover that connects to the proving valve arrangement. In the case of the Field LACT, the flow is blocked by the main line block valve. All flow runs through the prover and back into the system downstream of the main line block valve.

Truck and Rail LACT Loading

This operation is controlled by an operator. The loading control will be a preset volume amount with a controlled start-up and shut down to ensure the truck or rail car is not overloaded and that the loading process is safe throughout the entire batch. All safety devices and loading arms are connected. The operator will preset the volume amount into the controller, activating the preset valve. The controller accumulates the preset volume and commands the preset valve to close when the batch is complete. All other functions are the same as the Field LACT.

Truck and Rail LACT Unloading

The unloading operation is also controlled by an operator. No preset controller will be used since this is an unloading process and the receiving tanks are much larger than the unloading vessels. The operator connects all the safety devices and unloading arms. The pump is turned on and the vessel is unloaded. No divert system is installed at these locations as the "bad oil" should have been addressed at the loading site.

The major difference between loading and unloading is the issue of start-up and shut down. Transports do not travel with full hoses. When the vessel is connected at the unloading site, there is air or vapor in the system. These issues must be resolved prior to entering the metering stream. Depending on the design of the system, it may be desirable to install what is called a "manifold log" between the unloading hose/arm and the unloading pump. The log will have an air release device that will vent back to the vessel and will continue to do so until the level inside the log is satisfied and all "free" air/vapor has been eliminated. In this scenario, some sort of control logic will be needed to synchronize the pump start-up and shut down based on the level sensor input.

If entrained gases are present in the crude, a secondary air eliminator can be installed downstream of the pump and upstream of the meter. The air eliminator can also be the primary air/vapor release but it needs to be installed downstream from the pump. This device is a large vessel that slows the velocity of the stream, allowing time in the air eliminator for gases to separate and vent. Electronic controls can be added to air eliminators to synchronize the pump with level sensor input.

The BS&W and Sampler systems can operate like a Field LACT, however if a BS&W monitor and sampler is used, it will most likely be used only to record content and compare load data.

Factors Affecting Custody Transfer Measurement

Any time crude oil changes ownership (custody transfer) the main concerns are: quantity and quality. The three basic factors affecting quantity and quality are 1. Temperature, 2. API Gravity; and 3. BS&W Content. While these are the primary concerns, other operating conditions need to be reviewed.

Temperature

Crude Oil is transferred at a "Net Barrel" under the operating conditions of 60° F and 0 psi. The temperature effect on volume for crude oil varies significantly with change in API gravity (eg. 50°F change in temperature, 10°API = 0.36% volume change, 30°API = 0.48% volume change).

API Gravity

(API gravity, is a measure of how heavy or light a petroleum liquid is compared to water. If its API gravity is greater than 10, it is lighter and floats on water; if less than 10, it is heavier and sinks). Crude oil pricing is based on API gravity. Generally, lower gravity crude is less valuable than higher gravity crude. Light crude oil is liquid petroleum that has low density and flows freely at room temperature. It has low viscosity, low specific gravity and high API gravity due to the presence of a high proportion of light hydrocarbon fractions. It generally has low wax content as well. On the other hand, heavy crude oil or extra heavy crude oil is any type of crude oil that does not flow easily. It is referred to as "heavy" because its density or specific gravity is higher than that of light crude oil. Heavy crude oil has been defined as any liquid petroleum with API gravity less than 20°. Extra heavy oil is defined with API gravity below 10.0 °API.

Light crude oil receives a higher price than heavy crude oil on commodity markets because it produces a higher percentage of gasoline and diesel fuel when converted into products by an oil refinery. Heavy crude oil has more negative impact on the environment than its light counterpart since its refinement requires the use of more advanced techniques as well as use of contaminants. West Texas Intermediate, the US benchmark of crude oil, is a light, sweet crude oil with an API gravity of approximately 40 and a sulfur content of approximately 0.3%.

API gravity is typically determined by sampling the production stream to obtain a representative sample of the volume delivered at any given time. There are a number of factors that need to be considered to ensure that accurate sampling is accomplished. A homogenous sample of the pipeline content is needed to ensure that the sample is representative of the fluids flowing in the pipeline. It should be taken from a point that is representative of the entire cross section of the internal diameter of the pipe.

The size of each sample must be proportional to the flow at all times. Therefore, the sampling system must be able to accommodate changes in rate. The sample size must be repeatable (+/- 2%) to ensure it remains proportional. The sample size requirements are typically 10 liters over a 24 hour period at a given maximum pipeline flow rate and maximum sampling frequency or 10 liters for a specified batch at a defined maximum pipeline flow rate and maximum sampling frequency. The volume of sample required to be collected during the sampling period will depend upon the number and type of the laboratory analyses to which it will be subjected, plus sufficient surplus for a retention sample in the event of a dispute. The sampling system performance should be monitored and reported during the batch.

Basic Sediment and Water

The abbreviation for basic sediment and water is BS&W. BS&W is measured from a liquid sample of the production stream. It includes free water, sediment and emulsion and is measured as a volume percentage of the production stream. A BS&W Probe is an instrument which detects entrained water content in petroleum products wherein the water changes the capacitive reactance as a function of the dielectric constant (degree of conductivity) of the crude oil. Most probes typically measure by using some sort of capacitance, energy absorption, microwave or sub-megahertz technology which is all based on measuring the dielectric constants of crude oil due to changes in the water content.

LACT unit BS&W probes are typically set up for 0-3% water content. The accuracy can vary from 0.05% to 0.25% depending on the probe range and other operating conditions. They provide continuous measurement of the BS&W content and are a good indication of whether or not the oil is "merchantable" or in excess of the allowable BS&W content based on contractual agreements. The probe and/or monitor work in conjunction with the oil divert valve system. The divert valve is typically a three-way valve that when commanded, will allow oil flow (normal operating conditions) or divert either back to the storage vessel or to a wet oil treatment facility, or shut down depending on the application. The probe is typically connected to a BS&W Monitor or flow computer to store and manage data.

Meter Selection Guide

Accuracy

- Repeatability (any given flow rate)
- Linearity (over the given flow range)
- Stability (ability to reproduce repeatability and linearity over time)
- Provability (ability to prove meter performance and confidence level)

Meter Selection Criteria

Application Considerations

- Crude oil wells
- Condensate wells
- Operating flow range
- Temperature and pressure range (controls needed)
- Viscosity range
- API gravity range
- Percentage water range
- Wax
- Contaminants
- Corrosiveness
- Deposits

Positive Displacement Meters

Advantages –

- High accuracy
- Low pressure drop
- No flow conditioning
- Ability to measure high viscosities
- Can handle very low flows

Disadvantages –

- Application range limited by meter internal clearances
- Susceptibility to damage by flow surges or gas slugs
- Susceptibility to corrosion and erosion

Conventional Turbine Meters

Advantages –

- High accuracy
- Wide flow range
- Small in size and weight
- Low cost of ownership
- Wide temperature and pressure range

Disadvantages –

- Requires flow conditioning
- Requires back pressure control to prevent cavitation
- Difficulty with high viscosity liquids
- Susceptibility to fouling or deposits
- Sensitivity to changes in viscosity

Coriolis Meters

Advantages –

- Low maintenance
- Direct mass and density measurements
- No flow conditioning required
- Handles two phase emulsions
- Not susceptible to damage by gas slugging
- Little or no affect by viscosity changes
- Minimal affect by abrasives and corrosives
- Materials of construction available for harsh service

Disadvantages –

- Sensitivity to installation conditions (piping stresses, shock and vibration)
- Deposits on internals can cause errors in measurement
- Some meters have been known to be difficult to get good proving results
- Must have very accurate density to achieve good volume registration
- High pressure drop

Ultrasonic Meters

Advantages –

- High accuracy
- Wide dynamic flow range
- Negligible pressure drop
- Non-intrusive and no moving parts
- Small size and weight
- Diagnostic capabilities
- Bidirectional

Disadvantages –

- Highly sensitive to entrained gas
- Susceptibility to S&W, fouling, and deposits
- Sensitive to installed conditions
- Microprocessor-based output contributes to pulse delay/latency and difficulty in proving

Field LACT Control Panel

- Liquid Level Control I/O
- Charge Pump Motor Controller
- I/O required for discreet logic control of peripheral devices
- Panel Indicator Lights (Power/Alarm Failure/Mode)
- Quick Connect Pulse output for Proving
- Any manual override switches allowed by design
- BS&W Monitor w/appropriate controls inputs/outputs
- Sampler recirculation pump controls
- Flow Computer
  - Preset Capabilities
  - User-configurable inputs and outputs
  - Two-way data communications; built-in communication analyzer
  - Communication ports plus Ethernet port
  - Security
  - Event logging/Audit trail
  - Stand-alone operation
  - Continuous monitoring of critical function
  - Automatic temperature and pressure compensation and density correction
  - API tables
  - Prover Calculations
  - Automatic flow control w/ Programmable valve control
  - Transaction Data Archive

API Standards Reference Documents

Chapter 4.0 Proving Systems

Chapter 4.1 – Introduction

Chapter 4.2 – Displacement Provers

Chapter 5.0 Metering

Chapter 5.1 – General Considerations for Measurement by Meters

Chapter 5.2 – Measurement of Liquid Hydrocarbons by Displacement Meters

Chapter 5.3 – Measurement of Liquid Hydrocarbons by Turbine Meters

Chapter 5.4 – Accessory Equipment for Liquid Meters

Chapter 5.6 – Measurement of Liquid Hydrocarbons by Coriolis Meter

Chapter 5.8 – Measurement of Liquid Hydrocarbons by Ultrasonic Flow meters Using Transit Time Technology

Chapter 6.0 Metering Assemblies

Chapter 6.1 – Lease Automatic Custody Transfer (LACT) Systems

Chapter 6.7 – Metering Viscous Hydrocarbons

Chapter 7.0 Temperature Determination

Chapter 8.0 Sampling

Chapter 8.1 – Manual Sampling of Petroleum and Petroleum Products

Chapter 8.2 – Automatic Sampling of Petroleum and Petroleum Products

Chapter 8.3 – Standard Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products

Chapter 9.0 Density Determination

Chapter 9.1 – Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

Chapter 10.0 Sediment and Water

Chapter 10.1 – Standard Test Method for Sediment in Crude Oils and Fuel Oils by the Extraction Method

Chapter 10.3 – Standard Test Method for Water and Sediment in Crude Oil by the

Centrifuge Method (Laboratory Procedure)

Chapter 10.4 – Determination of Sediment and Water in Crude Oil by the Centrifuge Method (Field procedure)

Chapter 10.7 – Standard Test Method for Water in Crude Oils by Potentiometric Karl Fischer TitrationTR 2570 Continuous on-line Measurement of Water In Petroleum (Crude Oil and Condensate)

Chapter 11.0 Physical Properties Data (Volume Correction Factors)

Chapter 11.1 – Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils

Chapter 12.0

Chapter 12.2.1 – Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volume Correction Factors,

Chapter 12.2.2 – Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors,

Part 2 – Measurement Tickets

Chapter 12.2.3 – Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors,

Part 3 – Proving Reports

Chapter 13 Statistical Aspects of Measuring and Sampling

Chapter 13.1 – Statistical Concepts and Procedures in Measurement

Chapter 13.2 – Statistical Methods of Evaluating Meter Proving Data

Chapter 18 Custody Transfer

Chapter 18.1 – Measurement Procedures for Crude Oil Gathered From Small Tanks by Truck

Chapter 21 Flow Measurement Using Electronic Metering Systems

Chapter 21.2 – Electronic Liquid Volume Measurement Using Positive Displacement and Turbine Meters

Chapter 22.1 Testing Protocols – General Guidelines for Developing Testing Protocols for Devices used in the Measurement of Hydrocarbon Fluids

RP 1004

Bottom Loading & Vapor Recovery for MC-306 Tank Motor Vehicles

Std 1164
Pipeline SCADA Security

Revisions made to publication TP0A016 Rev/ 0.1 (2/12)

Page 5: Replace System Characteristics and Product Characteristics with Application Considerations.

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