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System Logic Description for Low-Activity Waste Facility Melter Process (LMP) System

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Notice

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History Sheet

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Acronyms and Abbreviations

Reference the piping and instrumentation diagrams' symbols and legend sheets as listed in the Applicable Documents section, for acronyms and abbreviations used in the Appendix.

ADS	air displacement slurry
AEA	Atomic Energy Act
DI	density indicator
DOE	US Department of Energy
DT	density transmitter
ILAW	immobilized low activity waste
IR	Infrared
LFP	LAW melter feed process system
LAW	low-activity waste/ low-activity waste vitrification facility
LMP	LAW melter process system
LOP	LAW primary offgas process system
LAH	level alarm high
LAHH	level alarm high high
LALL	level alarm low low
LI	level indicator
LSH	level switch high
LT	level transmitter
LVP	LAW secondary offgas/vessel vent process system
P&ID	piping and instrumentation diagram
PDAH	pressure differential alarm high-high
PDI	pressure differential indicator
PDT	pressure differential transmitter
RLD	radioactive liquid waste disposal system
TALL	temperature alarm low low
TDAH	temperature differential alarm high
TE	Temperature Element
TI	Temperature Indicator
TT	Temperature Transmitter
WTP	Hanford Tank Waste Treatment and Immobilization Plant

Glossary

Control system	Refers to electronic processors that perform regulatory and logical control functions necessary for normal plant operation
High-high	Refers to a notification in the control system that is activated when the applicable variable reaches a point that is significantly higher than that expected during normal operation
Low-low	Refers to a notification in the control system that is activated when the applicable variable reaches a point that is significantly lower than that expected during normal operation

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1 Introduction

The document describes the instrument control logic for instruments associated with sub-systems such as the LAW melters and film coolers, and as applicable, sub-system equipment such as piping, pumps, and associated leak detection systems.

2 Applicable Documents

24590-WTP-M6-50-00001, *P&ID Symbols and Legend Sheet 1 of 8*

24590-WTP-M6-50-00002, *P&ID Symbols and Legend Sheet 2 of 8*

24590-WTP-M6-50-00003, *P&ID Symbols and Legend Sheet 3 of 8*

24590-WTP-M6-50-00004, *P&ID Symbols and Legend Sheet 4 of 8*

24590-WTP-M6-50-00005, *P&ID Symbols and Legend Sheet 5 of 8*

24590-WTP-M6-50-00006, *P&ID Symbols and Legend Sheet 6 of 8*

24590-WTP-M6-50-00007, *P&ID Symbols and Legend Sheet 7 of 8*

24590-WTP-M6-50-00008, *P&ID Symbols and Legend Sheet 8 of 8*

24590-LAW-M6-LMP-00002, *P&ID – LAW Melter Process System Melter 1 Agitation Zone 3 & Level Detection System*

24590-LAW-M6-LMP-00005, *P&ID – LAW Melter Process System Melter 1 Electrode Extension Cooling & Glass/Plenum Temperatures*

24590-LAW-M6-LMP-00007, *P&ID – LAW Melter Process System Melter 1 Glass Pouring and Monitoring Instrumentation*

24590-LAW-M6-LMP-00008, *P&ID – LAW Melter Process System Melter 1 Discharge Heaters, Power Controls (1-4) & Air Lift – Eastside*

24590-LAW-M6-LMP-00010, *P&ID – LAW Melter Process System Melter 1 Discharge Heaters, Power Controls (1-4) & Air Lift – Westside*

24590-LAW-M6-LMP-00012, *P&ID – LAW Melter Process System Melter 1 Feed Nozzles Cooling System and Feed Nozzles*

24590-LAW-M6-LMP-00013, *P&ID – LAW Melter Process System Melter 2 Lid, Plenum and Offgas Ports Cooling System*

24590-LAW-M6-LMP-00032, P&ID – LAW Melter Process System Melter 2 Agitation Zone 3 & Level Detection System

24590-LAW-M6-LMP-00035, P&ID – LAW Melter Process System Melter 2 Electrode Extension Cooling & Glass/Plenum Temperatures

24590-LAW-M6-LMP-00037, P&ID – LAW Melter Process System Melter 2 Glass Pouring and Monitoring Instrumentation

24590-LAW-M6-LMP-00038, P&ID – LAW Melter Process System Melter 2 Discharge Heaters, Power Controls (1-4) & Air Lift – Eastside

24590-LAW-M6-LMP-00040, P&ID – LAW Melter Process System Melter 2 Discharge Heaters, Power Controls (1-4) & Air Lift – Westside

24590-LAW-M6-LMP-00042, P&ID – LAW Melter Process System Melter 2 Feed Nozzles Cooling System and Feed Nozzles

24590-LAW-M6-LMP-00043, P&ID – LAW Melter Process System Melter 2 Lid, Plenum Cooling System Ports Cooling System

24590-LAW-M6-LOP-00004, P&ID – LAW Primary Offgas Process System Melter 1 Offgas Film Coolers

24590-LAW-M6-LOP-00005, P&ID – LAW Primary Offgas Process System Melter 2 Offgas Film Coolers

24590-LAW-3YD-LMP-00001, System Description for LAW Melter Process System (LMP)

3 Description

The LMP components and ancillary equipment pertaining to instrumentation included in the dangerous waste permit are the following:

- LMP-MLTR-00001 LAW Melter 1
- LMP-MLTR-00002 LAW Melter 2
- LMP-BBLR-00055 Melter 1 Level Detector
- LMP-BBLR-00056 Melter 2 Level Detector
- LOP-FCLR-00001 Melter 1 Primary Offgas Film Cooler
- LOP-FCLR-00002 Melter 1 Standby Offgas Film Cooler
- LOP-FCLR-00003 Melter 2 Primary Offgas Film Cooler
- LOP-FCLR-00004 Melter 2 Standby Offgas Film Cooler
- LMP-LBD-00001 Melter 1 Feed Line Encasement Assembly
- LMP-LBD-00002 Melter 2 Feed Line Encasement Assembly
- LMP-ALFT-00001 Melter 1 Air Lift Lance – Eastside
- LMP-ALFT-00002 Melter 1 Air Lift Lance – Westside
- LMP-ALFT-00003 Melter 2 Air Lift Lance – Eastside
- LMP-ALFT-00004 Melter 2 Air Lift Lance – Westside

3.1 LMP-MLTR-00001 and LMP-MLTR-00002

The low-activity waste (LAW) melter receive a blend of low-activity waste concentrate and glass former additives from the melter feed process (LFP) system. The melter are fed via air displacement slurry (ADS) pumps. The melter convert the feed into molten glass and deliver it into stainless steel canisters. The pour spout connects the melter discharge chamber to the canister. After the glass is transferred into the canister, it cools to form a durable glass waste form. Immobilized low-activity waste (ILAW) is the resulting product (glass plus canister).

The feed slurry is transferred using six feed pumps, each supplying a separate nozzle on the melter. The slurry will fall from the nozzles, which are located in the melter lid, onto the surface of the glass pool within the melter. The feed material will form a distinct layer, often referred to as the "cold cap," on the surface of the glass pool. This system is also equipped to flush the feed lines with demineralized water, to clean the feed lines and to establish the cold cap prior to transferring waste. This is referred to as melter pre-feeding.

The melter are equipped with several plenum thermocouples, used primarily to determine the coverage of the cold cap. The plenum temperatures are averaged per heating zone as determined by the electrode placement. These zones are then averaged to a single melter plenum temperature. If this temperature falls below acceptable limits pre-feeding to the melter will be terminated. See figure 1 for more details on melter plenum temperature.

The LAW melter lid has a closed-loop cooling system operated at a low pressure necessary to meet the structural and thermal limits of the lid. The closed loop system consists of a pump, heat exchanger, and surge tank. The lower plate of the lid constitutes a safety significant pressure boundary. To protect this feature, safety significant TEs are utilized to report the temperature of the cooling water. If this temperature rises above the design limit for the lid the melter feed will be terminated. See figure 6 for details on melter lid temperature.

3.2 LMP-BBLR-00055 and LMP-BBLR-00056

The melter glass level detector functions using three gas purged probes penetrating the glass pool to different depths. By measuring the differential pressure between each of the legs the density and level of the glass pool are calculated. If the level rises above acceptable limits the control system will alarm and terminate slurry feeding. Glass discharge will be terminated if the glass pool level falls below acceptable limits. Operators will be alerted to the low level condition. See figure 2 for details on melter level detection. Section 3.4 discusses glass discharge in more detail.

3.3 LOP-FCLR-00001 through LOP-FCLR-00004

During normal operation the melter generates steam, gases, aerosols, vapors, and particulates, which are handled by the offgas systems LOP and LVP. Each melter has two attached film coolers, a primary and a standby, which serve as the interface between the offgas systems and the melter. The primary film coolers are designed to cool the offgas below the glass sticking temperature to minimize solids deposition on the walls of offgas piping. The standby film coolers are used to supplement the primary film coolers if upset conditions are detected in the melter plenum. The offgas system is designed to maintain a vacuum in the melter plenum for containment of the offgases. This vacuum is measured and controlled in part by

redundant differential pressure detectors between the melter plenum and the melter annulus. If the melter plenum differential pressure rises above acceptable limits the control system will alarm the operator and take the following actions:

- Terminates slurry feeding
- Terminates pre-feeding
- Opens the standby offgas line
- Disables demineralized water to the film coolers
- Disables air supply to the film coolers

For more details on plenum differential pressure detection see figure 3.

3.4 LMP-LDB-00001 and LMP-LDB-00002

The feed lines that transfer waste from the LFP system to the melters are housed in LMP-LDB-00001 and LMP-LDB-00002 as they travel between the process cells and the melter gallery. In each of these assemblies is a conductivity type leak detection cable. This leak detection cable runs throughout the assembly along entire length of the encasement and into the bellows of the encasement assembly. Each of the feed lines will be immediately adjacent to a portion of the leak detection cable. LMP-LDB-00001 drains to RLD sump 30 and LMP-LDB-00002 drains to RLD Sump 32. The control system will alarm the operator when a leak is detected. Once an alarm is activated, the operator will verify if a leak has occurred and if a leak has occurred stop feed to the melter. The leaking feed lines will be flushed and liquids in the encasement assembly will be removed in accordance with the requirements in the DWP permit condition III.10.E.5.j. See figure 7 for details on melter feed line leak detection.

3.5 LMP-ALFT-00001 through LMP-ALFT-00004

Each melter contains two identical, independently operated, discharge chambers located adjacent to each other on the south side of both melters. The glass is discharged by an airlift system which injects air into the discharge riser effectively raising the glass level in the riser. The glass will flow down a trough and through the discharge chamber and into the canisters for cooling, solidification, and storage. The level in the canister will be monitored by an IR camera and a thermal image of the canister will be displayed in the control room. Termination of a pour will generally be controlled by an operator based on this image. Forced cooling air targeted within the IR camera field of view called air knives, and thermally conductive paint will provide better detail of the temperature gradients, and in effect canister level, within the area monitored by the IR camera for LAW canisters. The control system will disable glass pouring from an airlift when any of the following occur:

- Glass pool level falls below acceptable limits
- IR camera thermal image analyzer detects a container level above acceptable limits
- Lift is in progress in the neighboring chamber
- Canister is not in position to receive the waste glass
- Discharge chamber temperature is not in the appropriate range for glass pouring

For more details on the melter airlifts see figures 4 and 5.

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System Logic Description for Low-Activity Waste
Facility Melter Process (LMP) System

Table 1 Associated Instruments for LAW Melters

P&ID	Monitoring/control parameter	Type of instrument/control device	Instrument/control device tag number
24590-LAW-M6-LMP-00005	Melter 1 Plenum Temperature Average	Temperature Element Temperature Transmitter Temperature Indicator	TE-1267C, 1272C, 1280C TT-1267B TI-1267C, 1272C, 1280C
24590-LAW-M6-LMP-00035	Melter 2 Plenum Temperature Average	Temperature Element Temperature Transmitter Temperature Indicator	TE-2267C, 2272C, 2280C TT-2267B TI-2267C, 2272C, 2280C
24590-LAW-M6-LMP-00002	Melter 1 Glass Pool Density	Density Transmitter Density Indicator	DT-1404 DI-1404
24590-LAW-M6-LMP-00032	Melter 2 Glass Pool Density	Density Transmitter Density Indicator	DT-2404 DI-2404
24590-LAW-M6-LMP-00002	Melter 1 Glass Pool Level	Level Transmitter Level Indicator	LT-1405 LI-1405
24590-LAW-M6-LMP-00032	Melter 2 Glass Pool Level	Level Transmitter Level Indicator	LT-2405 LI-2405
24590-LAW-M6-LMP-00002	Melter 1 Plenum Pressure	Pressure Differential Transmitter Pressure Differential Indicator	PDT-1410 / PDI-1410* or PDT-1411 / PDI-1411*
24590-LAW-M6-LMP-00032	Melter 2 Plenum Pressure	Pressure Differential Transmitter Pressure Differential Indicator	PDT-2410 / PDI-2410* or PDT-2411 / PDI-2411*
24590-LAW-M6-LMP-00007	Melter 1 West Canister Level	Level Element (IR Camera) Level Transmitter Level Indication	LE-1466 LT-1466 LI-1466B
24590-LAW-M6-LMP-00007	Melter 1 East Canister Level	Level Element (IR Camera) Level Transmitter Level Indication	LE-1511 LT-1511 LI-1511B

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System Logic Description for Low-Activity Waste
Facility Melter Process (LMP) System**

24590-LAW-M6-LMP-00037	Melter 2 West Canister Level	Level Element (IR Camera) Level Transmitter Level Indication	LE-2466 LT-2466 LI-2466B
24590-LAW-M6-LMP-00037	Melter 2 East Canister Level	Level Element (IR Camera) Level Transmitter Level Indication	LE-2511 LT-2511 LI-2511B
24590-LAW-M6-LMP-00010	Melter 1 West Discharge Air Lift	On/Off Plug Valve Valve Control	YV-1125 YC-1125
24590-LAW-M6-LMP-00008	Melter 1 East Discharge Air Lift	On/Off Plug Valve Valve Control	YV-1047 YC-1047
24590-LAW-M6-LMP-00040	Melter 2 West Discharge Air Lift	On/Off Plug Valve Valve Control	YV-2125 YC-2125
24590-LAW-M6-LMP-00038	Melter 2 East Discharge Air Lift	On/Off Plug Valve Valve Control	YV-2047 YC-2047
24590-LAW-M6-LMP-00012	Melter 1 Feed Encasement Assembly Leak Detection	Cable Type Conductivity Element	LE-1632 LAH 1632
24590-LAW-M6-LMP-00042	Melter 2 Feed Encasement Assembly Leak Detection	Cable Type Conductivity Element	LE-2632 LAH-2632
24590-LAW-M6-LMP-00013	Melter 1 Lid Cooling	Temperature Element	TE-1640
24590-LAW-M6-LMP-00005		Temperature Transmitter	TT-1293
24590-LAW-M6-LMP-00043	Melter 2 Lid Cooling	Temperature Indicator	TI-1640
24590-LAW-M6-LMP-00043		Temperature Element	TE-2640
24590-LAW-M6-LMP-00005		Temperature Transmitter	TT-2293
24590-LAW-M6-LMP-00005		Temperature Indicator	TI-2640

* These instrument sets are duplicates. Only one instrument set is required to remain functioning during waste feed operations.

Figure 1 Typical Temperature Averaging of a Melter Plenum

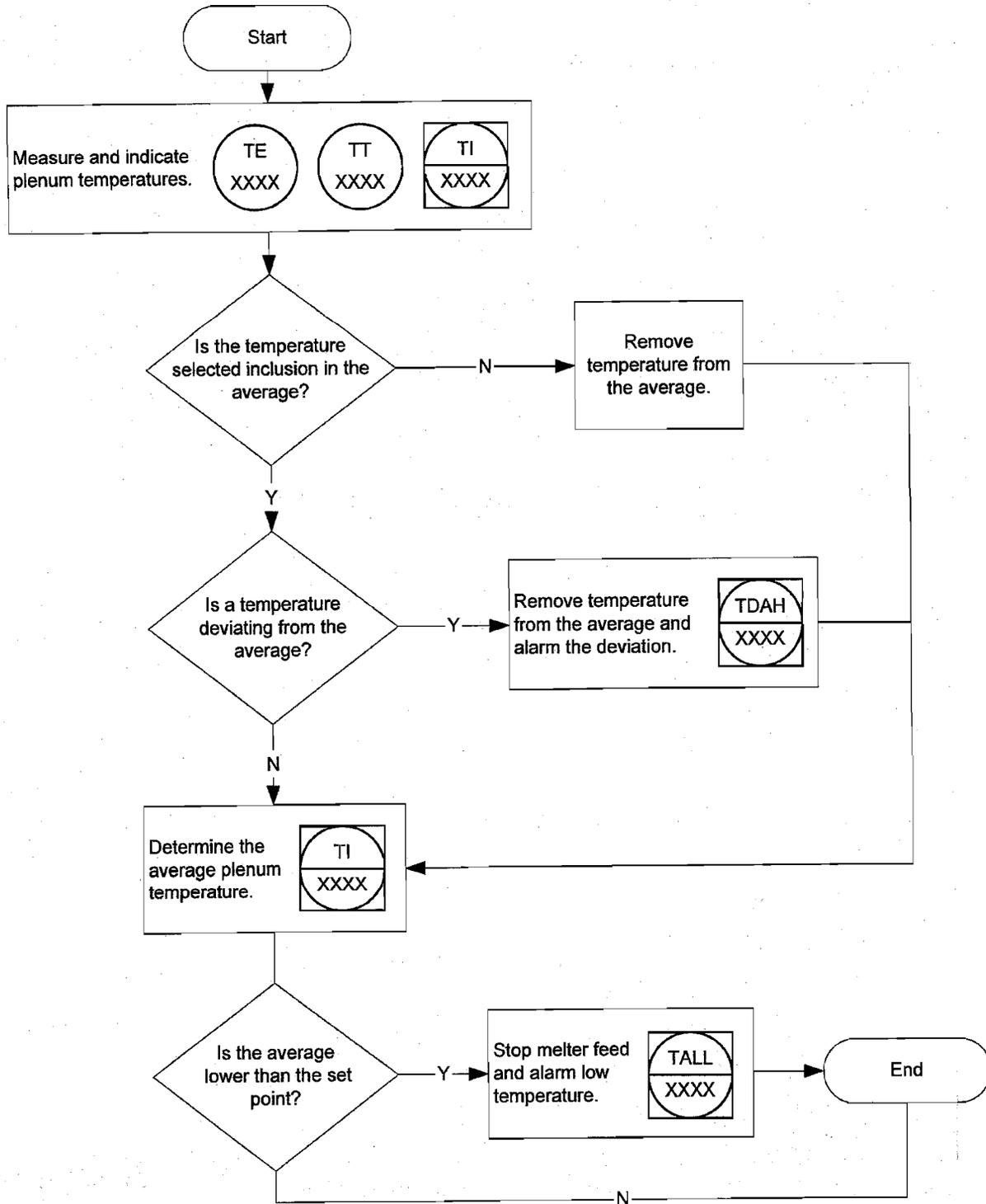


Figure 2 Typical Glass Pool Level and Density

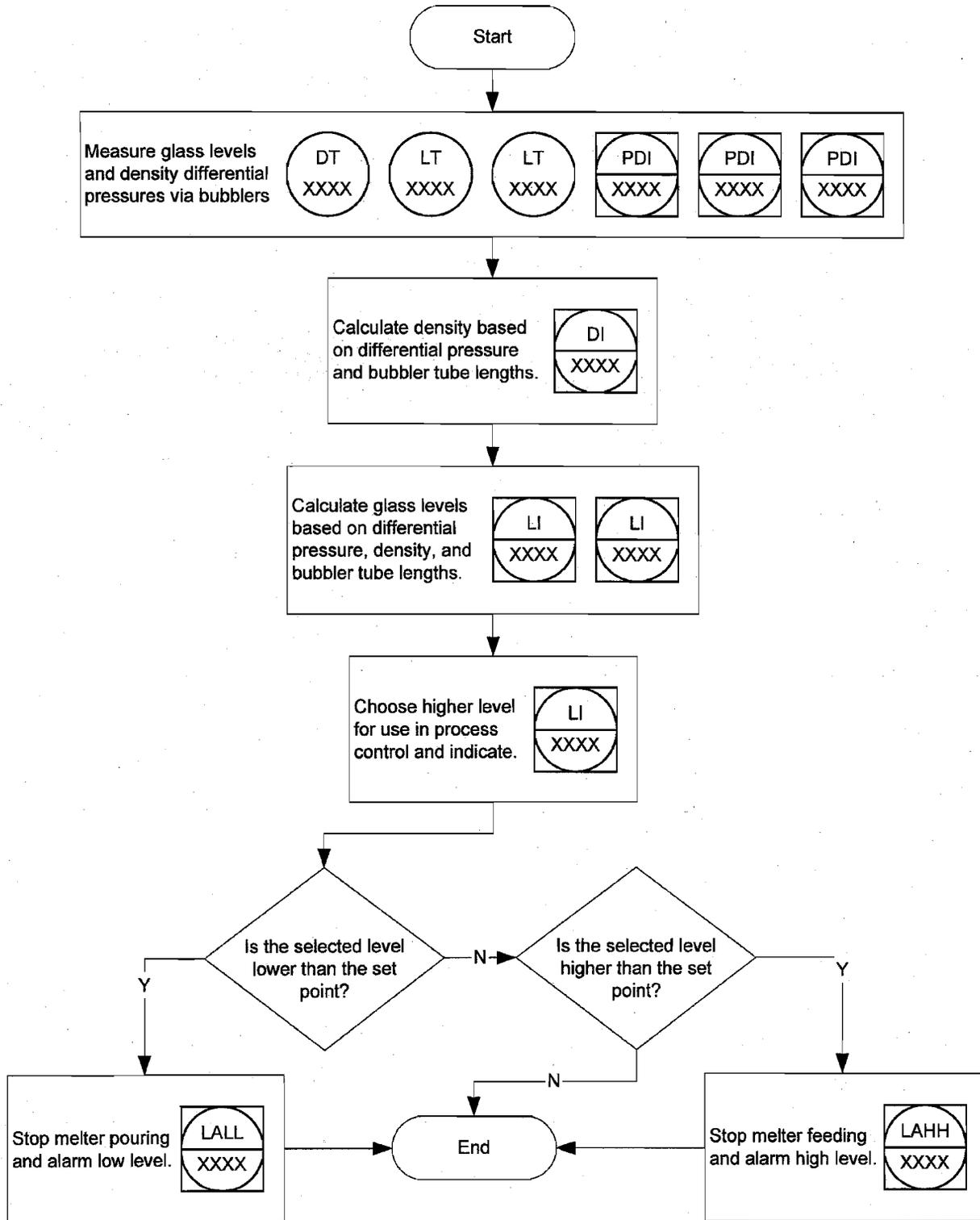


Figure 3 Typical Plenum Differential Pressure

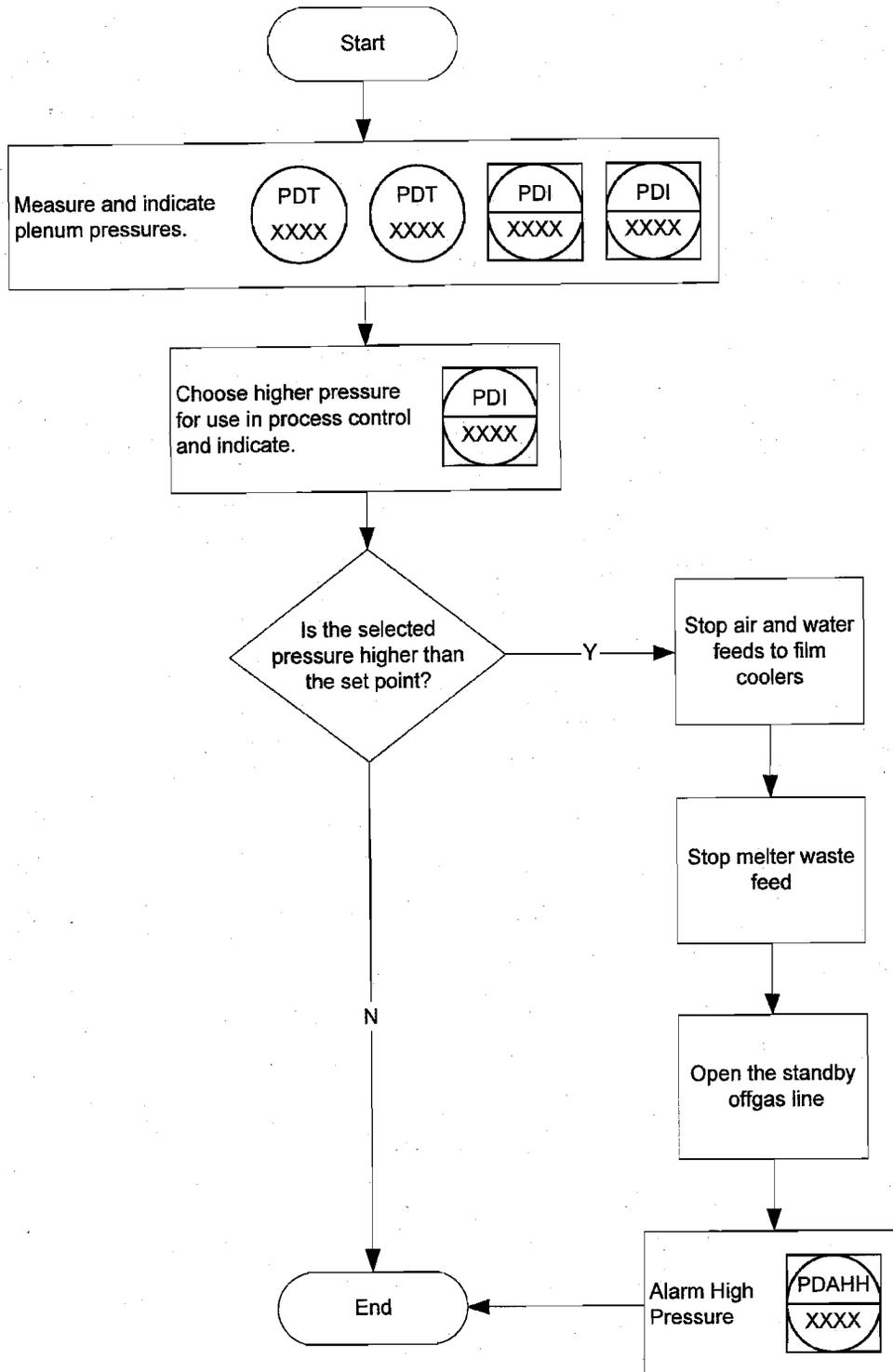


Figure 4 Typical IR Cameras

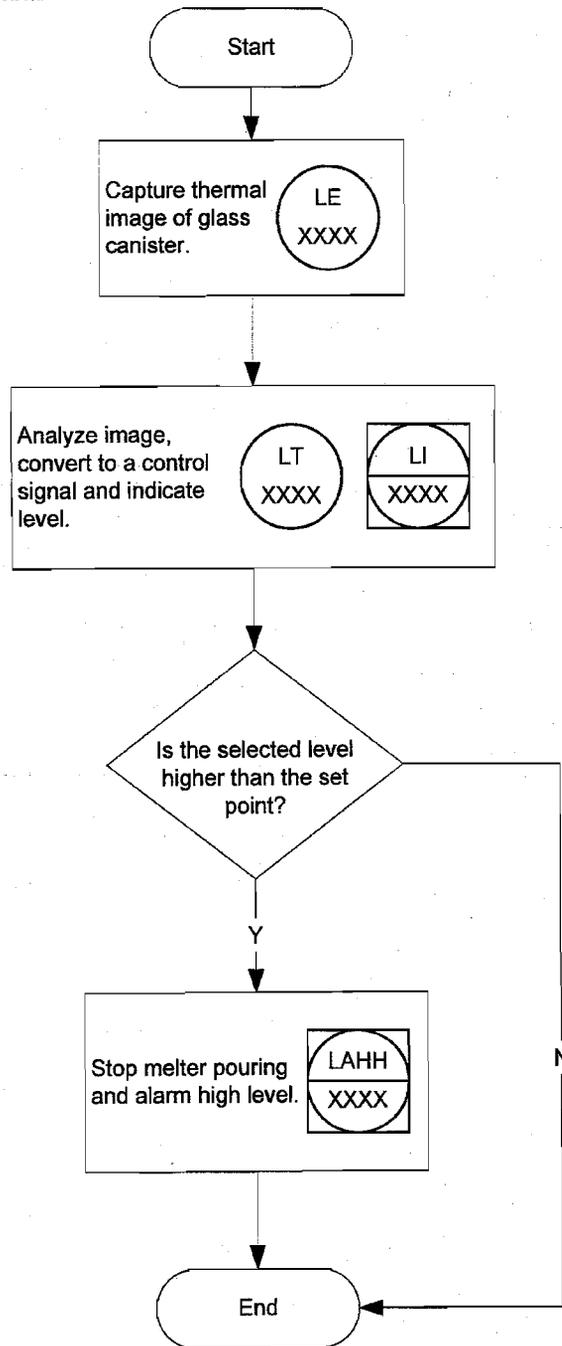


Figure 5 Typical Air Lift Valves

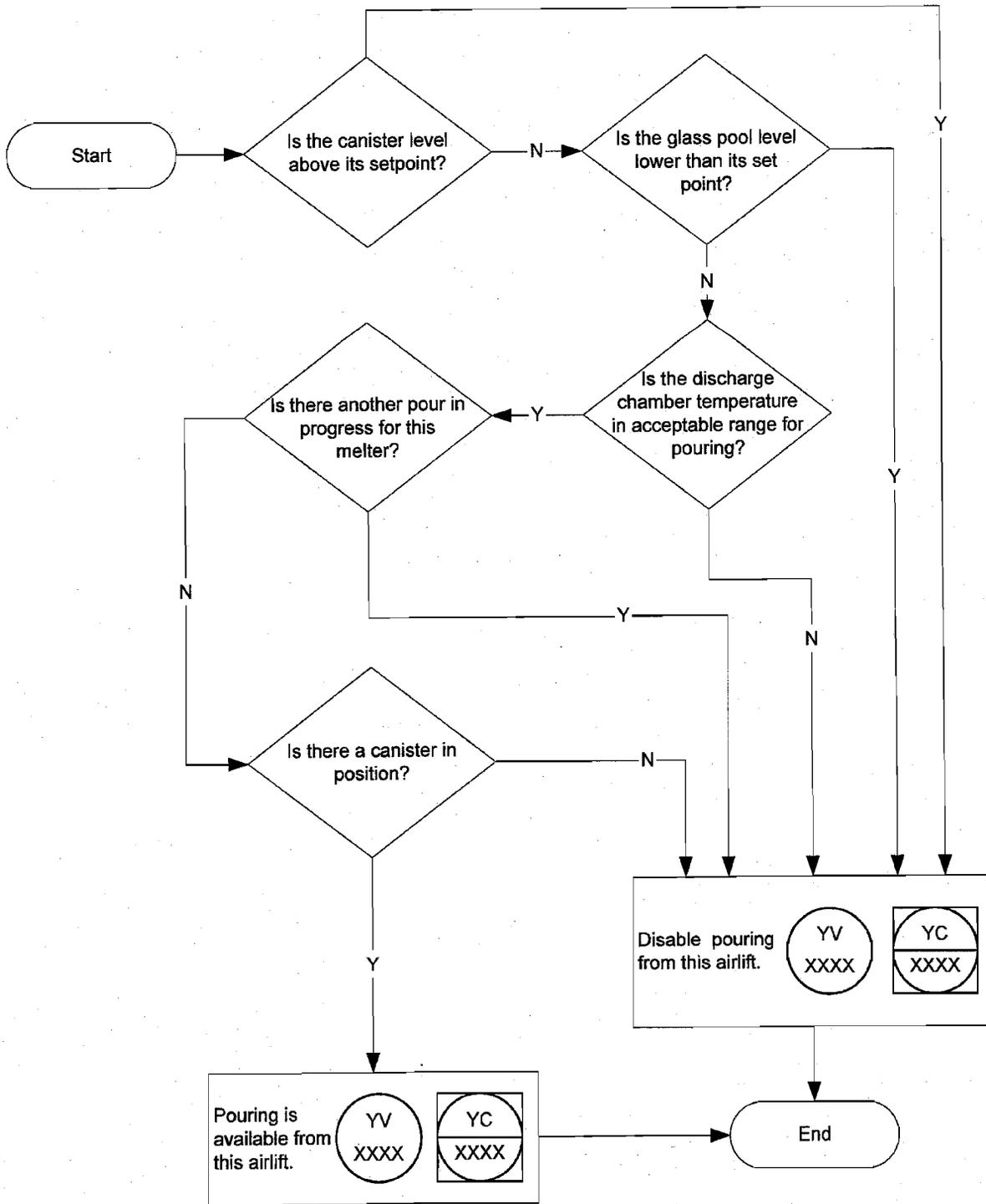


Figure 6 Typical Melter Lid Thermocouple

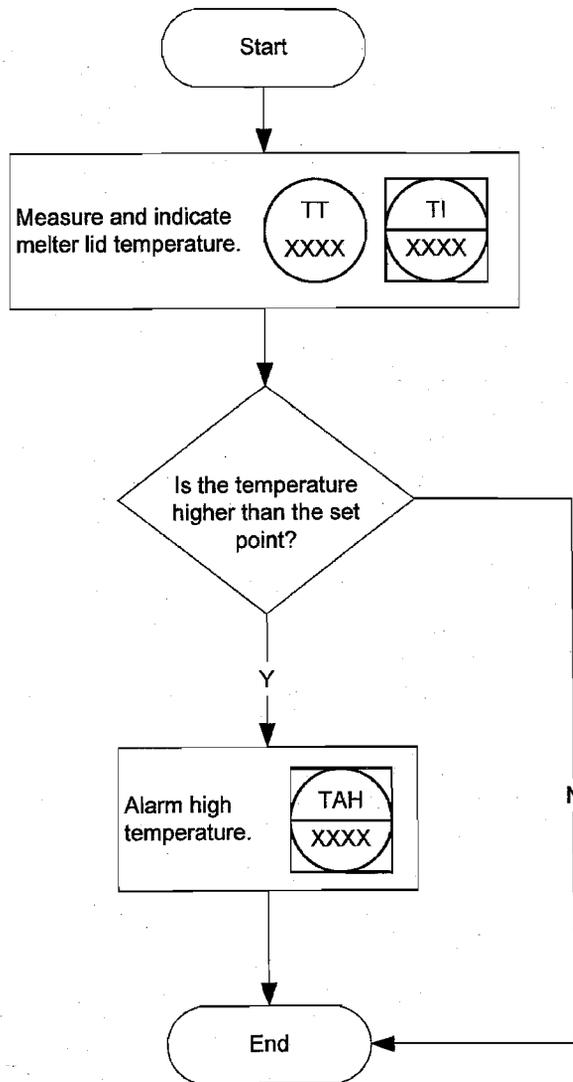


Figure 7 Typical Melter Feed Leak Detection

