5

DEC 28 1994

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT

601316

2. To: (Receiving Organization) DISTRIBUTION				3. From: (Originating Organization) SURV. SYSTEMS ENG. / 71760				4. Related EDT No.: 600745			
5. Proj./Prog./Dept./Div.: 241-SY-101 Color Camera Video Imaging System				6. Cog. Engr.: SM Werry				7. Purchase Order No.: 371963			
8. Originator Remarks: ETN-94-0028 The following SD is being distributed for information.								9. Equip./Component No.: NA			
								10. System/Bldg./Facility: 241-SY-101			
11. Receiver Remarks:								12. Major Assm. Dwg. No.: NA			
								13. Permit/Permit Application No.: NA			
								14. Required Response Date: NA			
15. DATA TRANSMITTED								(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted				Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-WM-SDD-054	A11	0	System Design Description 241-SY-101 Color Video Camera				NA	3	1	
16. KEY											
Approval Designator (F)				Reason for Transmittal (G)				Disposition (H) & (I)			
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)				1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)				1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged			
(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)								(G)	(H)
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3	1	Cog.Eng. SM Werry	<i>[Signature]</i>	12/27/94	N1-46	TL Moore			H5-09	3	
3	1	Cog. Mgr. DB Smet	<i>[Signature]</i>	12/28/94	N1-46	LT Pedersen			N1-46	3	
		QA				Central Files	<i>(2)</i>		L8-04	3	
		Safety				O.S.T.I. (2)			L8-04	3	
		Env.									
3		EH Kohlman			H5-09						
3		JL Castleberry			N1-46						
18. <i>[Signature]</i> 12/27/94 Signature of EDT Originator Date				19. _____ Authorized Representative Date for Receiving Organization				20. <i>[Signature]</i> 12/28/94 Cognizant Manager Date			
21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments											

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BD-7400-172-1 (07/91)

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Document Number: WHC-SD-WM-SDD-054, REV 0

Document Title: System Design Description 241-SY-101 Color Video Camera

Release Date: 12/28/94

**This document was reviewed following the
procedures described in WHC-CM-3-4 and is:**

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara M. Broz

December 28, 1994

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WHC-SD-WM-SDD-054

Rev. 0

SYSTEM DESIGN DESCRIPTION
241-SY-101 COLOR VIDEO CAMERA

Ed Kohlman / Dave Smet
December 1994

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SYSTEM DESIGN DESCRIPTION

241-SY-101 COLOR VIDEO CAMERA

1.0 Background of Camera System

The engineered 241-SY-101 (SY-101) camera system was designed for installation into the vapor space within tank SY-101. This one riser, two-camera remotely operated video system, will be used to observe and record the activities within the vapor space. Activities include, but are not limited to, monitoring of: core and augering sampling, movement of the crust layer, shrinkage and swelling of the crust level, monitoring of equipment installations/removals, and any other intrusive activities. The objective of the program was to provide the two-camera system for the Flammable Gas Waste Tank Safety Program as a prerequisite for any intrusive work.

2.0 System Description

The camera system is comprised of three major components: the camera assembly, the purge system, and the multiport riser unit.

The camera assembly further contains smaller subassemblies. Two camera assemblies are installed onto the camera mast assembly. One camera is mounted on a pan and tilt mechanism which has a 4:1 zoom operated

narrow field of view relative to the other camera. The other is a wider angle camera which is stationary and mounted between the mast's structural pipes, just below the lighting assembly. This camera is positioned looking at the mixer pump, 22° below horizontal. The cameras are mounted in 12.7 cm (5") diameter stainless steel cased, lead lined, purged housings. A special non-inverting, non-browning quartz prism is utilized in the design to protect the cameras and lens from tank radiation shine.

The pan and tilt unit (PELCO) has approximately a 359° horizontal rotation angle and a 120° vertical tilt motion, translating to a 30° above horizontal view angle. Combined with the camera's viewing angle, the system has full 360° pan viewing angle and ample upward viewing capabilities. The pan and tilt unit is also purged with nitrogen gas.

Lighting is provided by six 250 watt radiation sensitive (see system operation) Appleton Electric Company lights mounted in the lower section of the camera mast. The lights conform to the National Electrical Code for use in a Class I, Division 1, Group B atmosphere. The lights are arranged with two lights mounted side by side, three levels deep, each

level staggered 90° from each other. The electrical wiring to the lights are purged by a nitrogen gas blanket. The conduit housing the wiring as it leaves the mast is explosion-proof rated conduit.

The cameras, lights, and pan and tilt unit are mounted to a 5.8 meter (19') long camera mast constructed of four small diameter stainless steel pipes joined in the middle with a separation plate. At the top of the unit is a stainless steel nitrogen manifold containing all the electrical and camera connections. Covering the manifold is a 7.6 cm (3") thick shield plate. The entire camera is inserted into the 20-inch diameter port on the multiport riser.

The multiport riser is a 42" diameter riser adapter which converts the large diameter riser into four smaller sized flanged risers: a 20", a 12", and two 8" ports.

The camera system is installed in the 20" port of the multiport unit. The camera is orientated such that the stationary camera is pointed toward the center of the tank.

The multiport unit is fabricated entirely of stainless materials and weighs approximately 2,948 kg (6,500 lbs) dry.

The multiport unit was designed with an integral spray wash system. Four circular wash rings surround each port on the multiport

unit with individual valves and an inlet filter. An additional single nozzle is included and directed downward towards the center line of the camera. Its function is to spray down the camera's lens if the need arises. The spray wash system is designed to accommodate a pressure of 2.07 MPa (300 psig).

In addition, the multiport unit functions as a pressure relief device to protect the tank from over pressurization in the event of a tank burn. Blowout panels have been designed into the system. Special tabs installed on the panels will rupture if over pressurized, allowing a path for the gases to escape.

As a safety function on the system, the cameras are equipped with a purge system. The purge system displaces the existing air in the cameras, manifold, piping and tubing, and the pan/tilt units with a blanket of nitrogen gas. The displacement of the existing gas assures that any potential of flammable gas that may have been in the system is removed prior to activation of electrical components which may create sparks. The gas initially enters from a nitrogen dewar located on the perimeter of the SY Tank Farm. The gas is piped to the purge panel where it enters the system at approximately 698 kPa (100 psig). In the panel, the gas pressure is lowered to approximately 276 kPa (40 psig). The gas is then routed through a flowmeter and solenoid valve. During non-purge times the gas is

routed through a 14 kPa (2 psig) pressure regulator.

From here, the nitrogen gas is routed to the camera stem where it flows through the manifold system, down one of the structural pipes into the first camera, then onto the pan and tilt unit until finally passing through the second camera. On the return side, the gas is routed through the three remaining structural pipes purging the camera's lighting system. The gas is then routed back to the purge panel. At this location, a 5 psi check valve is installed to create system back pressure during static operation and a flow set switch to verify a minimum flow rate (currently set at 1 cfm) is attained. As a safety feature, the system has twin pressure switches which verify that a minimum of 25.4 cm (10") water column is maintained in the system at all times.

During a purge, the 14 kPa pressure regulator is by-passed. The system gas pressure is high enough to overcome the unseating pressure of the 5 psig check valve in the return line. The gas passes through the check valve and flow switch and is discharged back into the tank. After the purge cycle is complete, the system pressure returns to the 14 kPa (2 psig) setting. This pressure is lower than the pressure to overcome the 5 psig check valve; therefore a "static" system pressure is attained. System losses in the pan and tilt and other potentially leaking devices are compensated with a

continuous available flow of nitrogen purge gas.

3.0 System Operation

Operation of the camera and lighting systems are dependant upon successful completion of the purge cycle. The purging system consists of a control panel and a purging panel. The Purge Control Panel (PCP) is located in the video shack and includes the controls and system indicators and power control components. The Purge Panel is physically located adjacent to the camera equipment and provides the purge gas control and monitoring functions. Purge gas to the purge panel is manually valved in and out by operations.

The purging cycle is initiated by depressing the PCP "Start" push button until increased pressure is measured in the purge panel on the purge pressure return line. This illuminates the amber "Pressurized" indicator and the green "Purging" indicator allowing one of the two timers to begin a timing cycle. Pressure is independantly monitored for the second logic loop. When the minimum purging flow is achieved, and with adequate pressure, the second timer begins its cycle. Both timers must successfully complete the initiated action to allow energizing of the equipment. Two power control relays are provided to power the in-tank equipment (lights, cameras, pan and tilt). When both relays are energized and

electrical power is available to the camera equipment, the green "purging" indicator extinguishes and the red "In Service" indicator is illuminated. The logic provided by the PCP will not allow in tank equipment to be energized without a completed purge cycle. If either pressure sensing device fails to provide a signal indicating that adequate static purge pressure is available, the system is designed to drop out the corresponding control relay. The release of either control relay de-energizes all in-tank equipment and the red "In service" indicator will extinguish.

The lights are turned on via a panel breaker switch located in a new power panel in the video trailer. The camera and pan/tilt units can also be activated at this time. All supply power at the master control station used to control in-tank components are fitted with L620 twistlock plug connectors to prevent inadvertant tie-in to non-interlocked power that is also available at the master control location.

The controls for the camera and pan-and-tilt unit are provided by an integrated control system unit which provides controls for zooming in and out, iris up and down, and a full range camera integrator. On the same control panel is located the pan and tilt controls, comprising of tilt up and down and panning of left and right commands. The controls for the stationary camera are the iris up and down and the integration capabilities.

The camera units are Pulnix, TMC-7, integratable systems and are capable of 460 horizontal lines of resolution with a system light sensitivity of 33 lux minimum scene illumination. The cameras employ CCD image sensor technology.

The cameras are protected from gamma radiation intrusion from all angles by 1.5 inches of lead shielding at the sides and back, and an optically clear, non-inverting, non-browning quartz prism positioned in front of the image sensor allowing removal of the image sensor from the gamma shine path. The 1.5 inches of lead provide an attenuation factor of 100:1 for a 'hard gamma' energy level of .667 MeV (Cs 137), allowing a minimum life expectancy in the SY 101 vapor space of two years without significant degradation due radiation effect.

The cameras have individual color monitors and a still frame color printer. Each camera has its own SVHS¹ programmable video cassette recorder.

The lights, as mentioned above, constitute a radiation sensitive system, in that the globes that house the lamps are not constructed of non-browning casted glass. In order to compensate for this design deficiency, administrative controls require that the lights be left running continuously. Laboratory testing and field use experience show that the ultraviolet and heat energy generated mitigate

the browning process by approximately 40 per cent.

¹Super VHS. VHS is a trademark of VIDE-O-GO, Inc., Princeton, New Jersey.