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High Temperature Hot Water Generator Safety Valve Research at Wright-Patterson AFB, OH

Investigation of Chronic Safety Valve Leaks

Michael K. Brewer, Charles M. Schmidt, and John Tanner

Wright-Patterson AFB (WPAFB) tasked the U.S. Army Construction Engineering Research Laboratory (CERL) to investigate the best way to resolve the problem of incorrect safety valves installed on fired pressure vessels in high temperature hot water (HTHW) generators. Additionally, WPAFB requested help in controlling system pressure in the HTHW system during large load swings, and guidance on how to pipe expansion tank discharge to a blowoff tank.

CERL researchers visited the site, inspected the system, researched relevant specifications, and recommended that: (1) the screen interface for the computerized plant data recording system at Plant 1240 be modified to trend plant pressure and N_2 expansion tank level to help troubleshoot pressure control problems, (2) two "V" safety valves be installed on each HTHW unit, and (3) the blowoff valve, piping, and tank configuration be modified to eliminate water hammer.

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Foreword

This study was conducted for Wright-Patterson Air Force Base (WPAFB) under Military Interdepartmental Purchase Request (MIPR) No. NCEGCE99710201, dated 16 December 1998. The technical monitor was Tony Day.

The work was performed by the Energy Branch (CF-E), of the Facilities Division (CF), U.S. Army Construction Engineering Research Laboratory (CERL). Charles M. Schmidt is associated with Schmidt and Associates, Inc. The CERL principal investigator was Michael K. Brewer. Larry M. Windingland is Chief, CEERD-CF-E and Dr. L. Michael Golish is Chief, CEERD-CF. The CERL technical editor was William J. Wolfe, Information Technology Laboratory.

The Director of CERL is Dr. Michael J. O'Connor.

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1 Introduction

Background

Plant staff at Building 1240, Wright-Patterson Air Force Base (WPAFB), observed that the high temperature hot water (HTHW) generators did not have the correct safety valves installed for fired pressure vessels. Based on the U.S. Army Construction Engineering Research Laboratory's (CERL's) research experience with central heating plants (CHPs) and, in particular, coal-fired plants, WPAFB contacted CERL for information on safety valve requirements and to discuss the best way to resolve the problem. Specifically, plant staff requested support in investigating the correct type and size valve needed, and also in controlling system pressure in the HTHW system in Plant 1240 during large load swings. These swings cause over-pressure conditions and subsequent opening of the generator relief valves. Once the HTHW safety valves become unseated, they are more susceptible to leaking and discharging at pressures below their original setpoint.

After CERL researchers made their initial site visit, WPAFB staff also requested additional guidance on how to pipe the expansion tank discharge to the blowoff tank, including information on the sizing and location of the blowoff line piping to eliminate large vibrations in the piping when discharging HTHW to the blowoff tank.

Objectives

The objectives of this study were to: (1) provide base engineering staff with needed research and assistance to determine the correct safety valve combination at the HTHW plant at WPAFB, and (2) develop a long-term solution to the pressure control problems at the plant.

Approach

The research and assistance encompassed the following tasks:

1. *Analyze Current System.* CERL researchers and a CERL contractor, Schmidt and Associates, Inc. (SAI), inspected the current pressure relief system at Plant 1240.
2. *Specify Correct System at Plant 1240.* The team specified the correct size and type of valves and piping to meet the current boiler and pressure vessel code.
3. *Investigate Pressure Control System* (specified as an optional task, to be done if funds were available). The team inspected the pressure relief system at Plant 770 or other plant at WPAFB, investigated the cause of excessive pressure transients at Plant 1240, and recommended system modifications.
4. *Document Technical Support Findings.* Based on the information gathered and analyzed, a letter report was delivered to the sponsor describing the results of Tasks 1-3, which included recommendations and addressed any sponsor comments.
5. *Specify Correct Expansion Tank to Blowoff Tank Piping* (added June 1999). The team specified the correct size and type of valves and piping to meet the current boiler and pressure vessel code and enable plant operators to control system pressure more effectively.
6. *Document Results* (added June 1999). The letter report described in Task 4 was amended to include the results of Task 5.

Mode of Technology Transfer

It is anticipated that lessons learned from this project will also be transmitted to Headquarters, Air Force Civil Engineering Support Agency (HQAFCESA) and the U.S. Army Corps of Engineers Directorate of Military Programs (CEMP-ET) for inclusion in guide specifications and technical notes.

Units of Weight and Measure

U.S. standard units of measure are used throughout this report. A table of conversion factors for Standard International (SI) units is provided below.

SI conversion factors					
1 in.	=	2.54 cm	1 gal	=	3.78 L
1 ft	=	0.305 m	1 lb	=	0.453 kg
1 sq in.	=	6.452 cm^2	1 psi	=	6.89 kPa
1 sq ft	=	0.093 m^2	°F	=	(°C x 1.8) + 32
1 cu ft	=	0.028 m^3			

2 December 1998 Site Visit

Investigation and Observations

CERL and SAI conducted a site visit to WPAFB Plant 1240 on 22 December 1998. During the site visit, the investigation team examined the installed safety valves (Figure 1), reviewed plant drawings, recorded plant conditions, and interviewed plant staff. The team observed that the installed safety valves were not marked as the type required by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (ASME BPVC) Section I Part PG-110. ASME BPVC requires fired pressure vessels to be protected with "V" stamped safety valves. Additionally, the legibility of the valve data was poor. Table 1 lists the seven items required to appear on the name plate or etched on the valve body.

Two valves are required on each of the four HTHW units, for a total of eight safety valves. Only two of the installed valves had "V" stamps. One additional valve may have had a "V" stamp, but it was hidden from view by the HTHW generator piping. Three valves had "UV" stamps. "UV" valves are not permitted on fired pressure vessels built and operated as ASME BPVC Section I systems. Two valves had neither "V" nor "UV" stamps. Appendix A to this report tabulates the legible data collected as part of this inspection.

The team was concerned that the boiler inspectors did not note any of these discrepancies in Section V (Inspection of Safety Devices) of the most recent inspection reports.

Data Analysis and Recommendations

The team reviewed the data and the ASME BPVC. The team observed the plant's margin for operation would not accommodate large swings in pressure. Interviews with the operators revealed that the mix of two- and three-way control valves on the HTHW system, when coupled with the event of rapidly shutting down on a HTHW/steam converter, causes the return temperature to rapidly increase 15 to 20 °F.

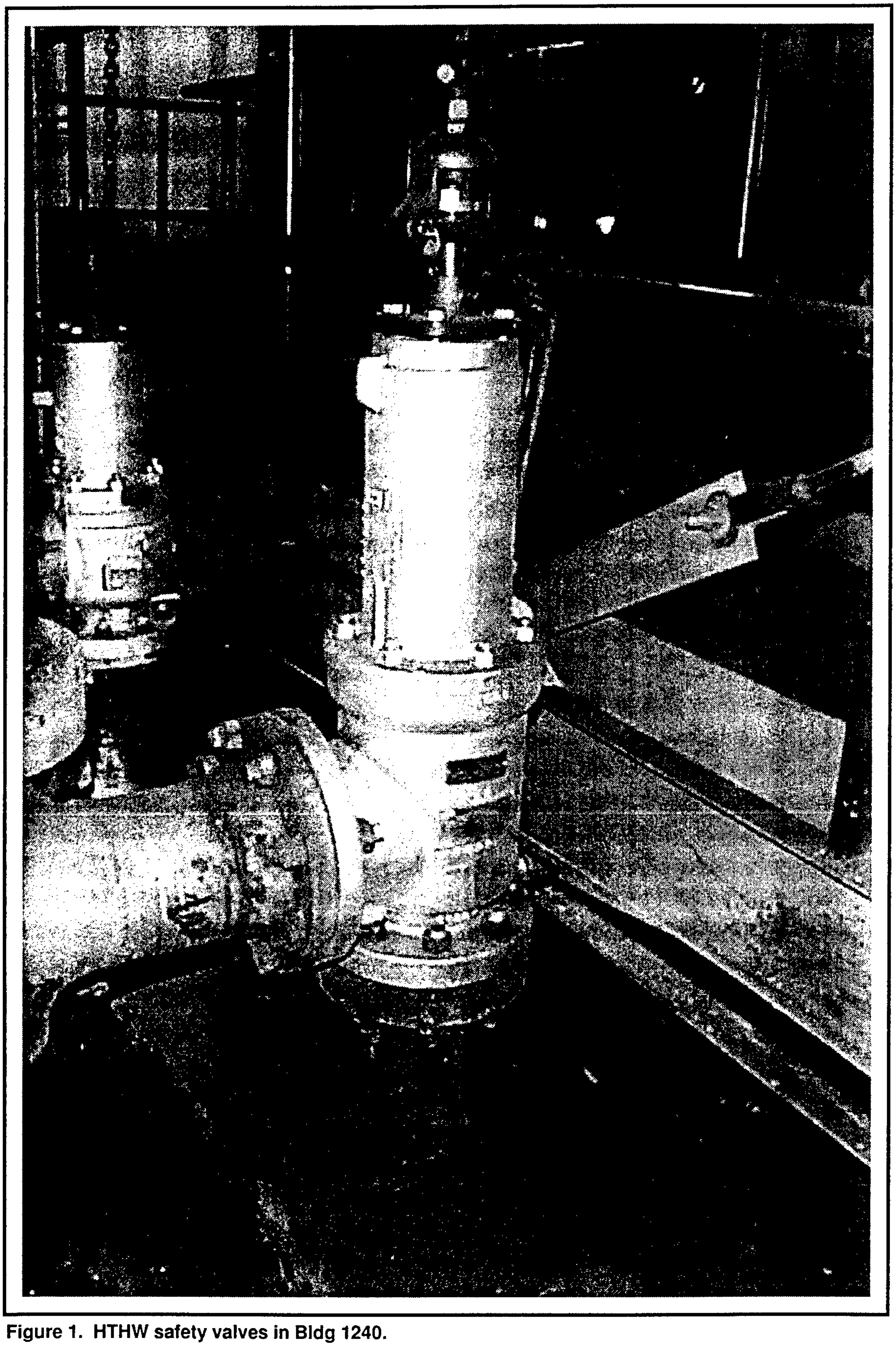

Figure 1. HTHW safety valves in Bldg 1240.

Table 1. ASME BPVC Section I, PG-110 safety valve marking requirements.

Name of manufacturer
Manufacturer's design or type number
Nominal pipe size of the valve inlet
Set pressure (psi)
Capacity (lb/hr or gpm for reliefs)
Year built or code to identify year built
ASME "V" symbol

Plant 1240 has a computerized plant data recording system that is useful for investigating plant upsets. Unfortunately, system pressure is not recorded as a trend. It is recommended that the screen interface be modified to trend plant pressure and nitrogen (N_2) expansion tank level (Figure 2) to help operators and maintainers troubleshoot pressure control problems.

Based on the code requirements and the available information, the team recommends that two "V" safety valves be installed on each HTHW unit. These valves should be sized to relieve the full HTHW unit capacity at 6 percent of the maximum allowable working pressure (MAWP) of 500 psig.

The team also recommends further investigation of how to most effectively control plant pressure during large temperature excursions. The team concurs with the plant practice of limiting operating pressure to no more than 440 psig. It may prove helpful to improve the controls on the N_2 expansion tanks by adding or removing water to control pressure, in addition to adding level control for water inventory. Another option would be to increase expansion tankage so that a given level change would reflect a much smaller pressure swing.

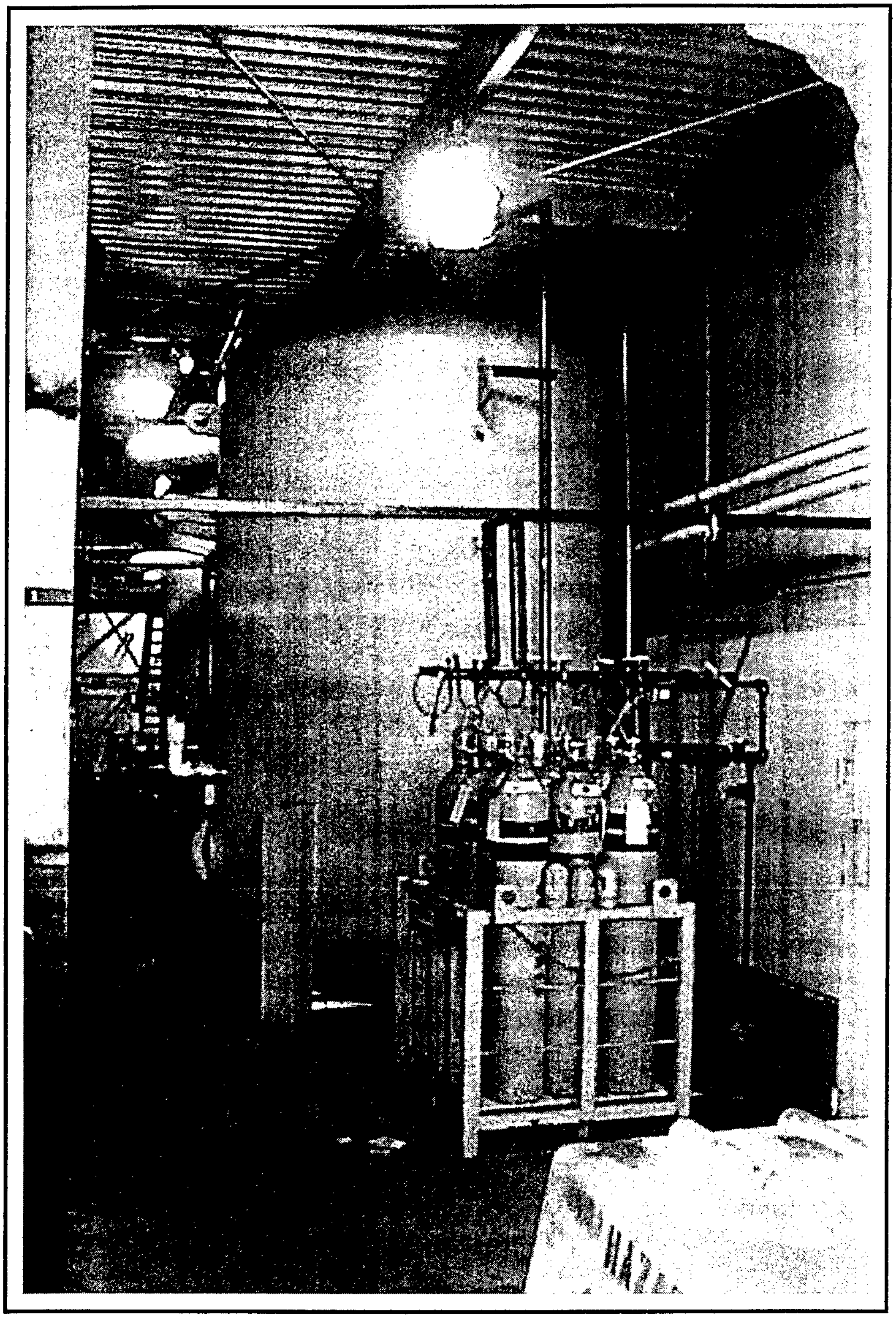

Figure 2. Nitrogen (N_2) expansion tanks.

3 Safety Valve Specification

The team recommends that two "V" stamped valves be installed on each of the four HTHW generators. The valves must meet the following requirements.

Number of Valves

ASME BPVC Section I, PG 67.1 requires that 2 "V" stamp valves be installed where the bare tube water heating surface of the HTHW units is greater than 500 sq ft.

Capacity

ASME BPVC Section I, PG 67.2.4 requires that the relieving capacity of the valve system for HTHW units be the maximum output at the nozzle in Btu/hr divided by 1000. For the coal-fired units, the capacity of the pair of valves must be equal to or greater than 143,000 lb/hr (110 percent of full load, 2-hour peak load). For the gas-fired unit, the capacity of the pair of valves must be equal to or greater than 88,000 lb/hr (110 percent of full load, 2-hour peak load). ASME Section I, PG 71.1 requires that, when two safety valves are mounted, the smaller capacity valve shall not have a capacity of less that 50 percent of the larger capacity valve.

Setpoint

ASME BPVC Section I, PG-67.3 requires that the setpoint of one or more of the valves be at or below the MAWP of the pressure vessel. The highest setting of any of the valves in a pressure relief system shall not exceed the MAWP by more than 3 percent. The units at Plant 1240 have a MAWP of 500 psig. One of the "V" valves will need to be set at or below 500 psig. The second valve will need to be set at or below 515 psig. Footnote 18 to ASME BPVC Section I, PG-67.3 recommends that HTHW safety valves be set as high as possible above the operating pressure as they are much more susceptible to damage and leakage than the steam safety valve. Also relieving flashing hot water from the safety valves is more damaging to the valve than relieving steam. However, the valves at Plant

1240 still cannot be set above 500 psig and 515 psig due to the MAWP limit. ASME BPVC Section I, PG-72.2 allows a popping tolerance of 10 psi for pressures between 300 and 1000 psi. Therefore, the 500 psig valve may actually open between 490 psig and 510 psig. ASME BPVC Section I, PG-72.3 prohibits adjusting the set pressure more than 5 percent above or below the pressure marked by the manufacturer without a determination by the manufacturer that the new setting is within the spring design range.

Water Temperature Limits

ASME BPVC Section I, PG-67.5 requires that HTHW safety valves be constructed and set to relieve water at the saturation temperature of the valve setpoint. For Plant 1240, the valve set at 500 psig must be able to operate with water at 464 °F, and the valve set at 515 psig must be able to operate with water at 467 °F.

Materials

ASME BPVC Section I, PG-67.5 requires that HTHW safety valves be constructed with a closed bonnet. ASME BPVC Section I, PG-67.7 prohibits the use of bronze parts in HTHW safety valves. ASME BPVC Section I, PG-71.37 prohibits the use of cast iron bodies in HTHW safety valves.

Blowdown Limit

ASME BPVC Section I, PG-69.1.4 and PG 72.1 require that HTHW safety valves not blow down to a pressure less than 10 percent of the set pressure. For plant 1240, the 500 psig relief must reseat before the pressure drops to 450 psig. The 515 psig safety must reseat before reaching 463.5 psig.

Safety Valve Connection to the Unit

ASME BPVC Section I, PG-71.2 requires that HTHW safety valve be attached as closely as possible to the HTHW unit. The connecting piping shall not be longer than the face-to-face dimension of the corresponding "T" fitting of the same pipe and pressure specification for the unit. ASME BPVC Section I, PG-71.3 requires that piping between the HTHW unit and safety valve have a cross-sectional area equal to or greater than the safety valve inlet.

Safety Valve Discharge and Drains

ASME BPVC Section I, PG-71.3 requires that HTHW safety valves discharge into a section of pipe that is as short and straight as possible. ASME BPVC Section VII, C4.130 recommends that the manufacturer be consulted if anything more than a short elbow and drip pan is attached to a safety valve. ASME BPVC Section I, PG-71.3 requires that HTHW safety valves greater than nominal pipe size (NPS) 2½ have an open gravity drain on the body below the valve seat with a hole not less that NPS 3/8 (0.675 in.). Ample drains for steam and condensation shall be provided. Cast iron body safety relief valves are prohibited on HTHW units. The discharging pipe on HTHW safety valves shall also have provision for discharge of water as well as steam. All the safety valves at Plant 1240 are greater than NPS 2½ (3x4 and 4x6). ASME BPVC Section VII, C2.310 recommends that the discharge piping and drain be open to the atmosphere and free to expand without imposing loads on the safety valve. To minimize the chance of roof damage, a safety relief valve separator should be installed to allow the water to drain separately to the plant drains instead of going to the roof with the steam. It is vitally important that the piping and the separator not impose a load on the safety valve. The valve will not open at the set pressure if any external load is imposed. Appendix B cites an incident where an externally loaded safety valve would not open until the set pressure was exceeded by 100 percent.

Markings

ASME BPVC Section I, PG-110 requires that HTHW safety valves be marked with a "V" stamp and with the data mentioned in Table 1 of this report. The stamp shall be plainly marked in a durable fashion. ASME BPVC Section VII, C4.120 strongly recommends that, if a valve's setting is changed from the manufacturer's setting, the old setting must be marked out, but left legible. The new setting should be reviewed with the valve manufacturer to ensure valve compliance. ASME BPVC Section VII, C4.230 strongly recommends that the repairing activity attach a nameplate identifying the repairer and the date of repair. BPVC Section VII, C4.230 also strongly recommends that the original valve nameplate never be removed from the valve. To remove doubt as to the meaning and intent of the marking requirement in ASME BPVC Section I, PG-110, the committee issued interpretation I-92-38 Section I, PG-110 on 14 October 1992:

> *Question*: Must the safety valves required for it (sic) Section I boiler be "V" stamped?
>
> *Answer*: Yes.

UV Valves Prohibited

ASME BPVC Section VII, C4.220, in its discussion of safety relief valves and relief valves for liquid, specifically states the HTHW safety relief valves must meet Section I ("V" valve) requirements. To address the issue that UV valves are not permissible on non-steam Section I vessels, the committee issued interpretation I-92-42 Section I, PVG-12.5 on 14 October 1992:

> *Question*: May a Section VIII "UV" stamped safety valve be used on a Section I organic fluid vaporizer?
>
> *Answer*: No, the overpressure used to determine relieving capacity and the blowdown requirements used for "UV" valves differ from those Section I "V" stamped safety valves.

4 Other Safety Valve Requirements

Due to the susceptibility of HTHW safety valves to damage and leakage, the plant will need to observe extra precautions operating and maintaining valves.

Lift Tests

ASME BPVC Section I, PG-73.1.3 prohibits manually lifting a HTHW safety relief valve when the water temperature exceeds 200 °F. However, if a lift check is done to verify that the mechanism is free, the valve shall be subject to at least 75 percent of set pressure during the test (ASME BPVC Section VII, C2.330).

Accumulation Tests

Although steam safety valve capacity can be determined with an accumulation test, ASME BPVC Section I, NMA A-46.1 strongly discourages doing (i.e., operative wording is "should not" do) accumulation tests on an HTHW safety valve. An accumulation test is firing the boiler at maximum capacity and shutting all other steam discharge outlets. ASME BPVC Section I, NMA A-46.3 prohibits verifying safety valve capacity by measuring feedwater in an accumulation test.

Gagging of Safety Valves

ASME BPVC Section VII, C2.430 prohibits the gagging of safety valves on operating units unless the capacity of the remaining valves equals or exceeds the requirements for the HTHW unit.

Valve Repair Cycle

ASME BPVC Section VII, C4.110 strongly recommends that safety valves receive regular maintenance. ASME suggests safety valves receive maintenance on a yearly cycle.

Valve Handling

ASME BPVC Section VII, C4.120 strongly recommends that safety valves not be stored or transported on their sides. Care should be taken to maintain vertical alignment of the valve when installing or transporting.

Valve Records

ASME BPVC Section VII, C4.120 and C4.230 strongly recommend that detailed inspection, operation, testing, pressure setting, and valve repair records be maintained.

Valve Testing

ASME BPVC Section VII, C4.130 strongly recommends that safety valves be thermally stable before any testing. Additionally, a safety valve gag should not be applied until the valve has been at approximately 80 percent of operating pressure for 2 hours to avoid spindle damage from thermal expansion.

Plant Operating Pressure

ASME BPVC Section VII, C4.130 strongly recommends that the system operating pressure be at least 7 percent below the safety valve setpoint and not less that 30 psi below the safety valve setpoint. For the HTHW units at Plant 1240, the maximum recommended operation pressure should not exceed 465 psig. ASME BPVC Section VII, C4.222 strongly recommends the system operating pressure be below the closing pressure of a safety relief valve (blowdown). At Plant 1240, the 500 psig safety valve can blowdown 10 percent of 500 psig to 450 psig. If the 10 psig tolerance is considered, the valve can blowdown as low as 441.5 psig.

Corrosion from Leaking

ASME BPVC Section VII, C9.350 strongly cautions operators to guard against leaking safety valves and connections that may drip condensate on pressure vessel parts. The water and condensate may run under casing and insulation and rapidly corrode the pressure vessel part.

5 July 1999 Site Visit

Investigation and Observations

On 1 July 1999, CERL and SAI visited WPAFB to collect data and assess the problems reported with the blowoff valve and blowoff piping. The assessment team collected data from the logs, inspected the systems, and interviewed plant staff to determine the cause of the problem. The team observed that the root cause of the problems with blowoff piping vibrations is that the operators have to discharge HTHW frequently to maintain the N_2 tank level.

The team concluded that the N_2 system is undersized for the volume change transients now experienced by the plant. The most complete solution would be to greatly increase the N_2 tankage. To handle the reported plant water volume increase of almost 200 cu ft (ranges calculated of 108 to 189 cu ft), the N_2 tankage would need to be increased almost 13 times to avoid letting the water level in the N_2 tanks increase more than 2 in. The team also examined other less costly options to reduce stress on the piping from discharging HTHW to the blowoff tank.

Data Analysis and Recommendations

The total volume HTHW distribution for Plant 1240 is 216,000 gal. There are five HTHW generators, three coal-fired units, and two gas/oil-fired units, as described in the December 1998 site visit. (Figure 3 shows a system schematic for Plant 1240.) The return temperature is typically about 350 °F at 425 psig. HTHW units are brought on line to best match the system load with the fewest number of units operating at maximum capacity. Additionally, before starting an on-coming HTHW unit, HTHW is circulated in the cold unit to heat the furnace surfaces. This reduces thermal stress and corrosion in the on-coming units. During such transitions (bringing units on- or offline), the distribution bulk temperature can vary causing the water volume to shrink or swell. Another type of event is the rapid loss of load due to a HTHW-to-steam converter being rapidly shutdown. This causes the bulk water temperature of the return and supply lines to increase, and causes the system volume to increase (i.e., to swell into the N_2 tank).

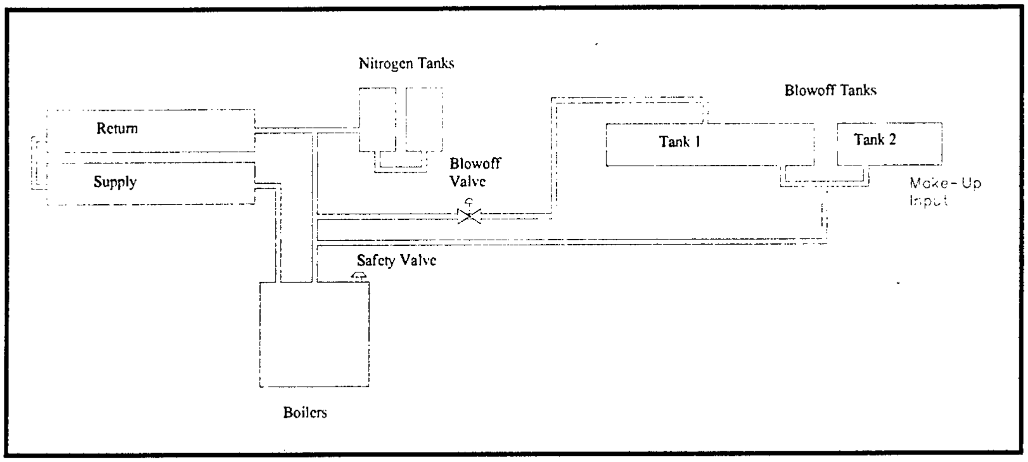

Figure 3. Plant 1240 HTHW system schematic.

Based on discussions with the operators, the team defined a large excursion as the return temperature jumping from 300 to 330 °F and the supply temperature jumping from 415 to 420 °F. This temperature change is due to the large thermal inertia of the HTHW distribution system. Note that, even though the HTHW-to-steam converters have ceased to draw energy from the supply lines, there is a large volume of water in route to meet the load. The energy in the supply line will move into the return side and greatly elevate the return temperature.

The current discharge piping arrangement (Figure 4) experiences large vibrations when discharging HTHW to the blowoff tank (Figure 5). When a transient necessitates discharge of HTHW, the blowoff valve (Figure 6) opens to release water at 350 °F and 440 psig to near ambient conditions. The pressure at the outlet of the valve will be slightly above ambient conditions due to flow resistance, but the increase in pressure will not be sufficient to prevent some of the HTHW from flashing to vapor. At 350 °F, steam occupies about 180 times more space than liquid water. Although only about 20 percent of the HTHW will flash to steam at atmospheric pressure, the acceleration of the two-phase mixture in the discharge pipe will cause severe water hammer.

The plant staff was also concerned that the present location and size of the overflow piping of the blowoff tank could cause damage to the plant roof. The steam created when the HTHW flashes into steam is vented out of the blowoff tank to the roof (Figure 7). The roof was inspected; currently there appears to be no damage to the plant roof. However, should there be prolonged venting, vent drains and piping should be installed to minimize exposing the flat roof to hot water and steam. If needed, SAI can provide drawings and specifications of typical vent drains.

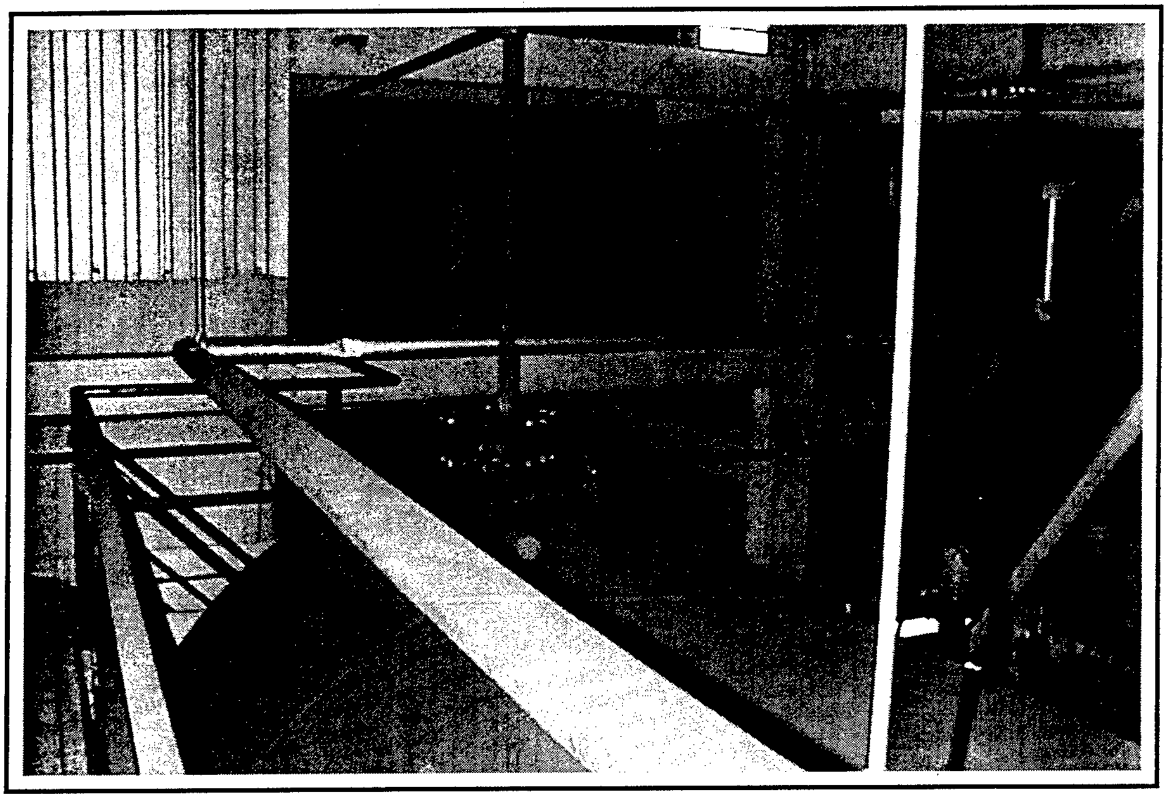

Figure 4. HTHW blowoff piping.

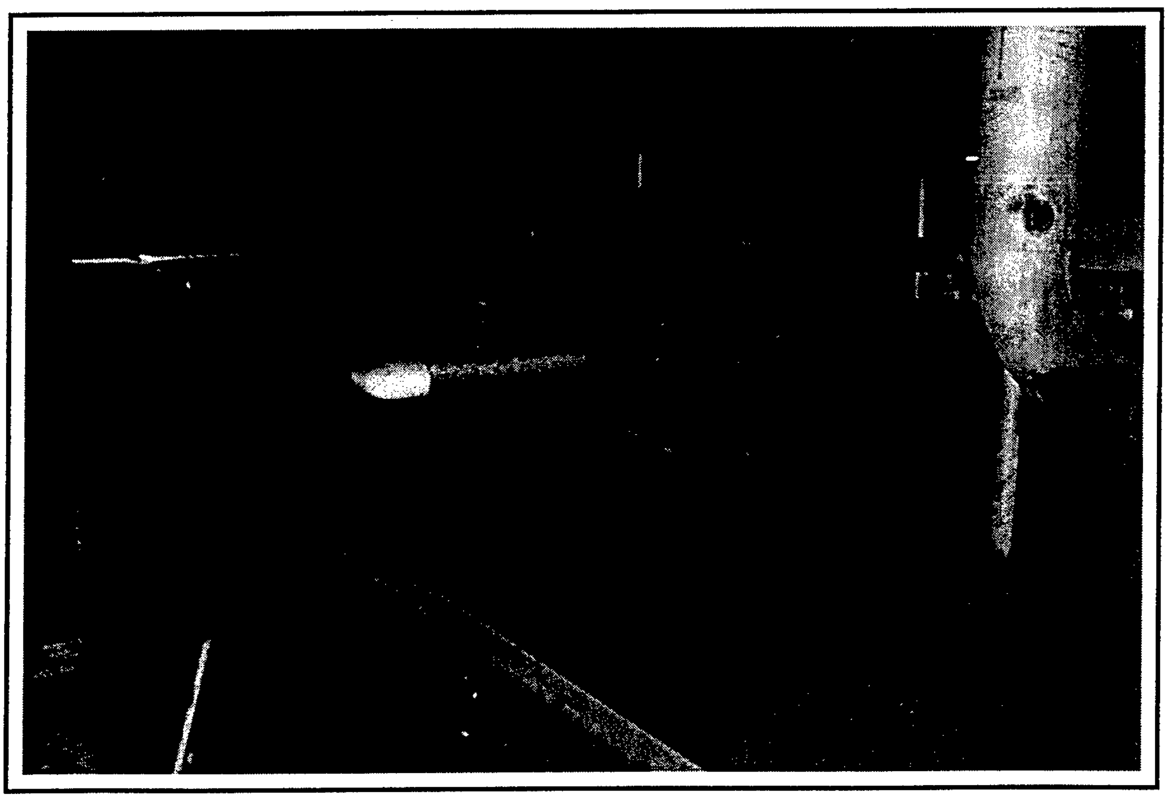

Figure 5. HTHW blowoff tanks.

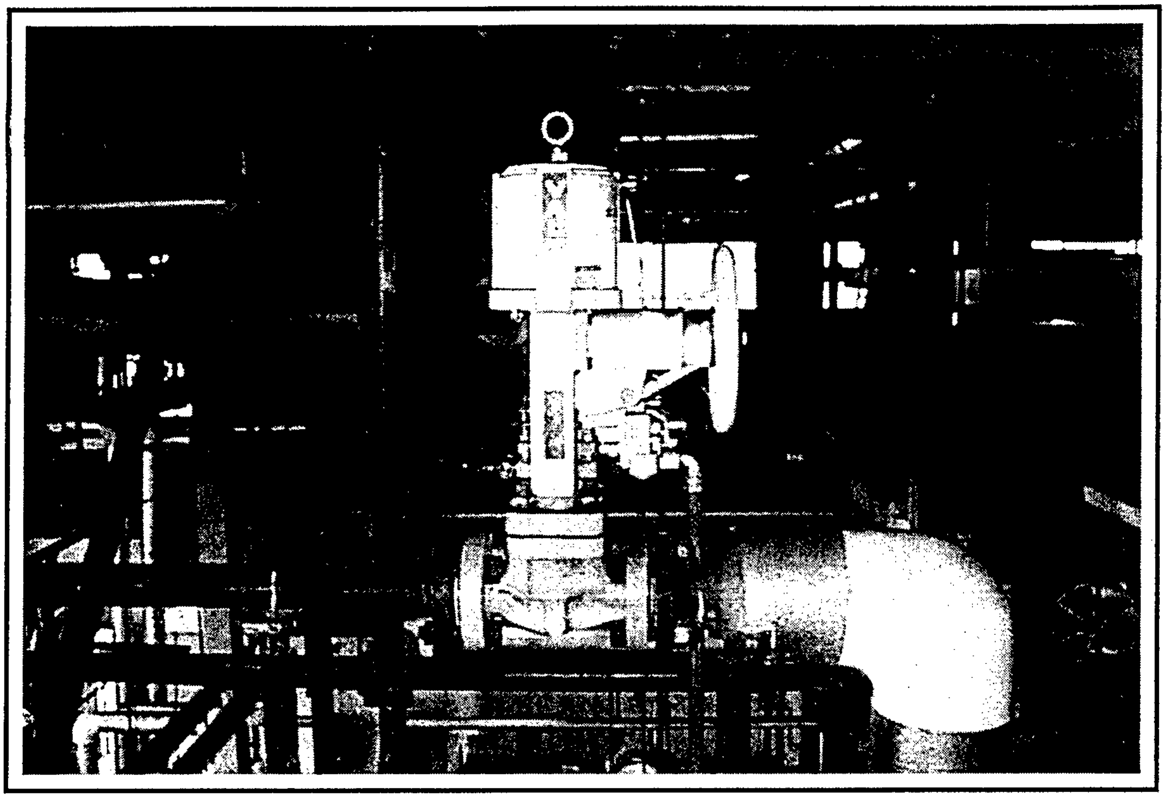

Figure 6. HTHW blowoff valve.

The team and plant staff concluded that the valve is not placed in the best position to minimize water hammer when discharging HTHW to the blowoff tanks. The team recommended that the blowoff valve would have the least water hammer when located to discharge into the top of the blowoff tank (Figure 8). This would eliminate two-phase flow in the discharge line from the blowoff valve to the blowoff tank.

With the large amount of discharge and makeup to control plant pressure, it is critical to aggressively monitor and control the dissolved oxygen level in the system. Large amounts of dissolved oxygen in the water can cause pitting on the insides of the piping, HTHW generators and blowoff tanks. The pitting will be worse in components where the HTHW temperature dramatically increases.

As mentioned above, the root cause of the pressure control and HTHW discharge water hammer is an inadequate N_2 tank surge volume. Since the N_2 tank is undersized, the plant staff has to discharge and charge water to the system frequently. To eliminate or minimize water hammer, CERL and SAI recommended several options for modifying the pipe leading to the blowoff tank. The most complete solution would be to greatly increase the number of N_2 tanks. However, that solution does not seem financially acceptable at this time.

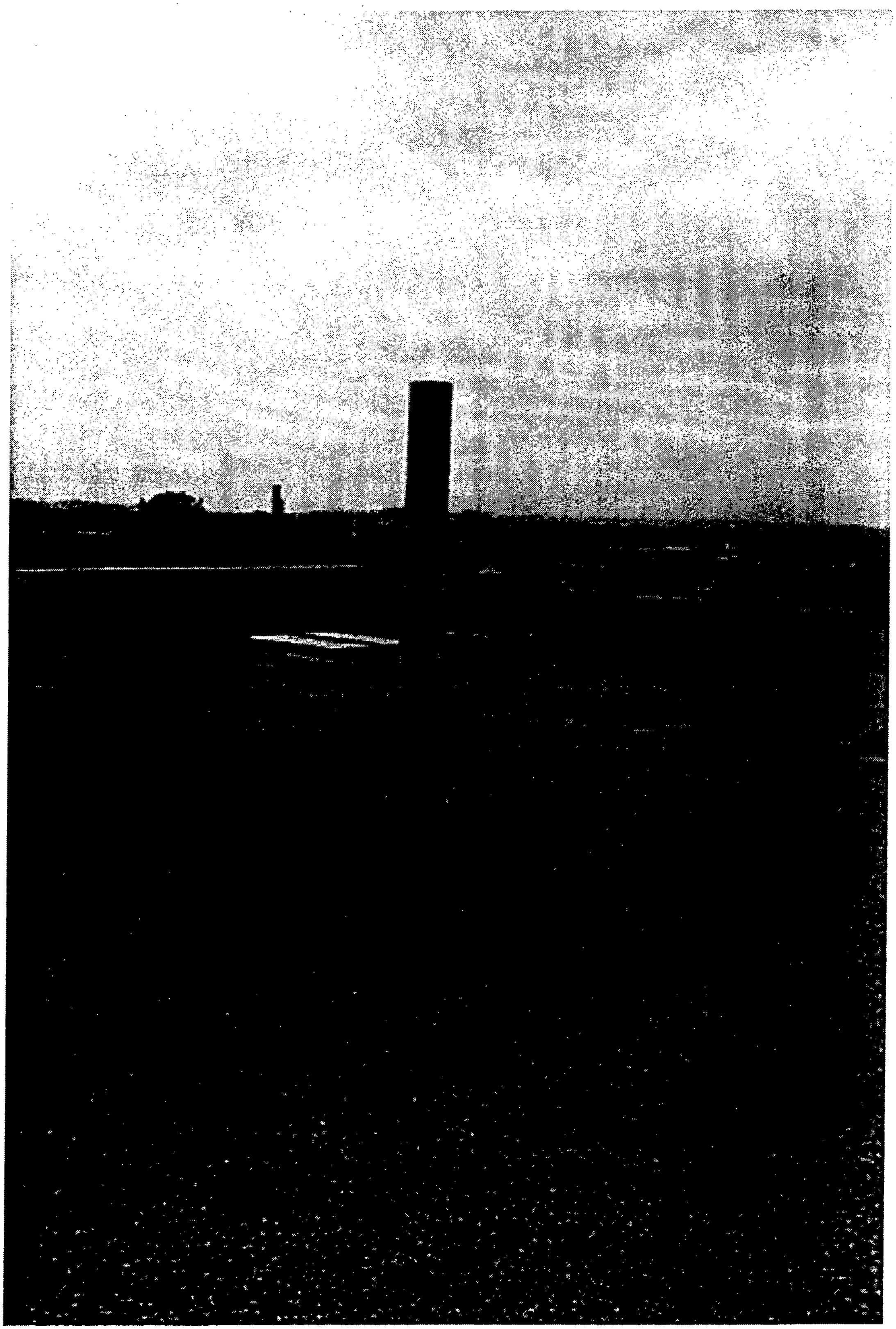

Figure 7. Blowoff tank vent on the roof of Bldg 1240.

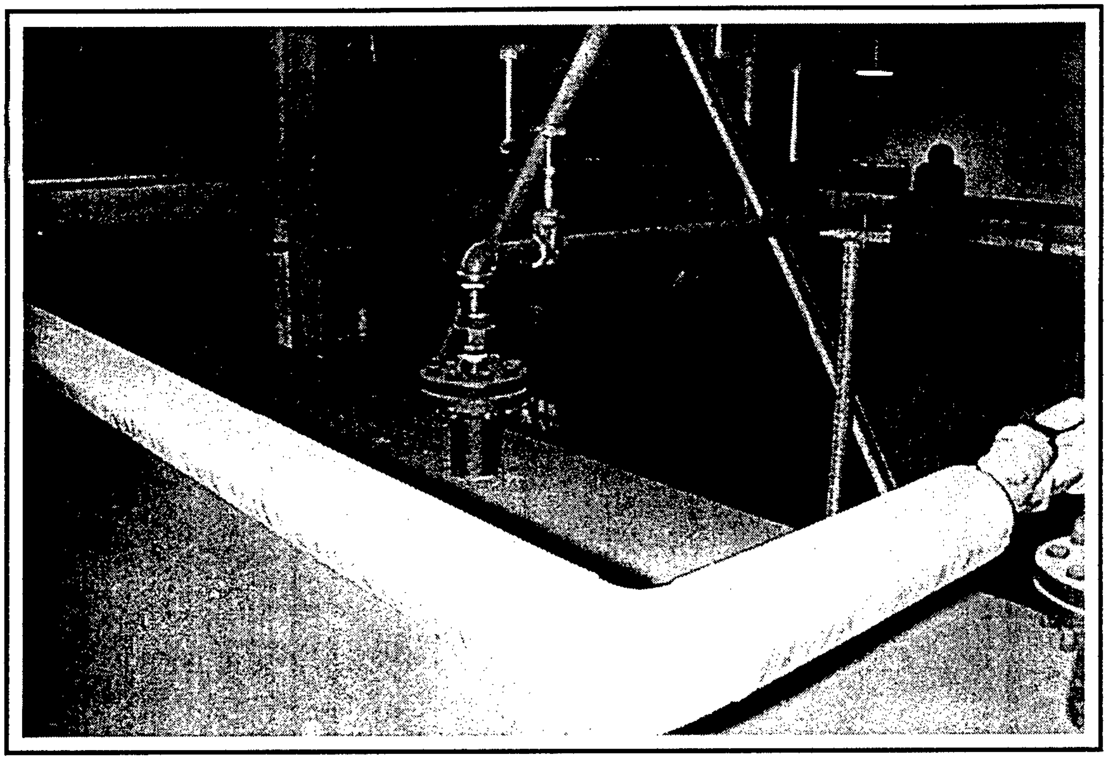

Figure 8. Top of blowoff tank.

The least costly solution would be to move the HTHW blowoff valve to the top of the blowoff tank. The discharge of the 1.5-in. valve would expand into an 8-in., schedule 80 pipe as it enters the expansion tank. The expansion will drastically reduce the flow velocity in the pipe. HTHW flashing to steam will still make noise, but some noise could be reduced by installing sound attenuating material around the blowoff valve area. Figure 9 shows the recommended configuration.

A more complete solution is to install a nitrogen pad or steam blanket on the blowoff tank so the tank pressure can be kept above the saturation pressure of the discharging HTHW. Keeping the tank pressurized at about 160 psi would eliminate steam flashing in the HTHW lines or blowoff tank. However, this modification would require changes to all of the adjoining equipment such as:

- adding safety relief valves to the blowoff tank
- replacing or modifying the makeup water pumps that take a suction from the blowoff tank
- replacing or modifying the treated water pumps that feed to the blowoff tank
- adding a nitrogen (N_2) pressurization system or a steam pressurization system
- upgrading or adding water treatment system for oxygen removal
- removing the old heater tanks downstream of the blowoff tank that are not rated for blowoff tank system pressure (150 to 300 psig).

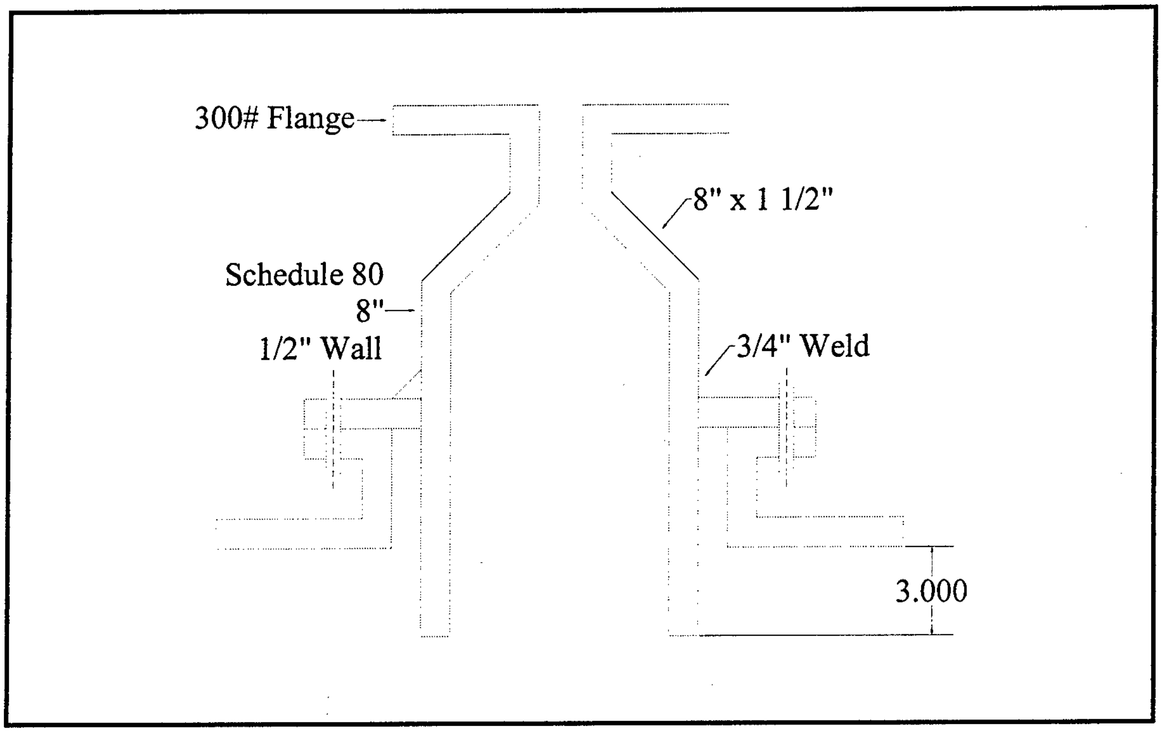

Figure 9. Blowoff valve modification.

Regardless of what solution WPAFB selects, the system needs to be modified to eliminate HTHW blowoff line water hammer. Additionally, the pipe anchoring needs to be corrected to allow for thermal expansion. The current bracing (Figure 10) seems to over-constrain the piping that was vibrating due to water hammer. The pipe needs to be allowed to expand along its length to prevent bowing in the pipe. This could be done with a three-sided rectangular piece of metal. The three-sided rectangular piece of metal should be as long as the pipe itself. The pipe should be placed between the two opposite sides of the piece of metal. The pipe should then be anchored with some u-bolts that will clamp the pipe to the piece of metal.

To combat dissolved oxygen in the water, the team recommends treating the makeup water with sulfite or other industrial water oxygen scavengers. Makeup water treatment combined with regular testing should control dissolved oxygen in the tank and prolong system life span. However, WPAFB personnel should take care to *not* overtreat the system with sulfites; extreme sulfite levels have been linked to flow accelerated corrosion (FAC) in hot water systems. The two main sources of the free oxygen in the HTHW system at WPAFB are maintenance actions that require opening and draining extensive sections of the HTHW system and water level control procedures that require adding large amounts of cold makeup water.

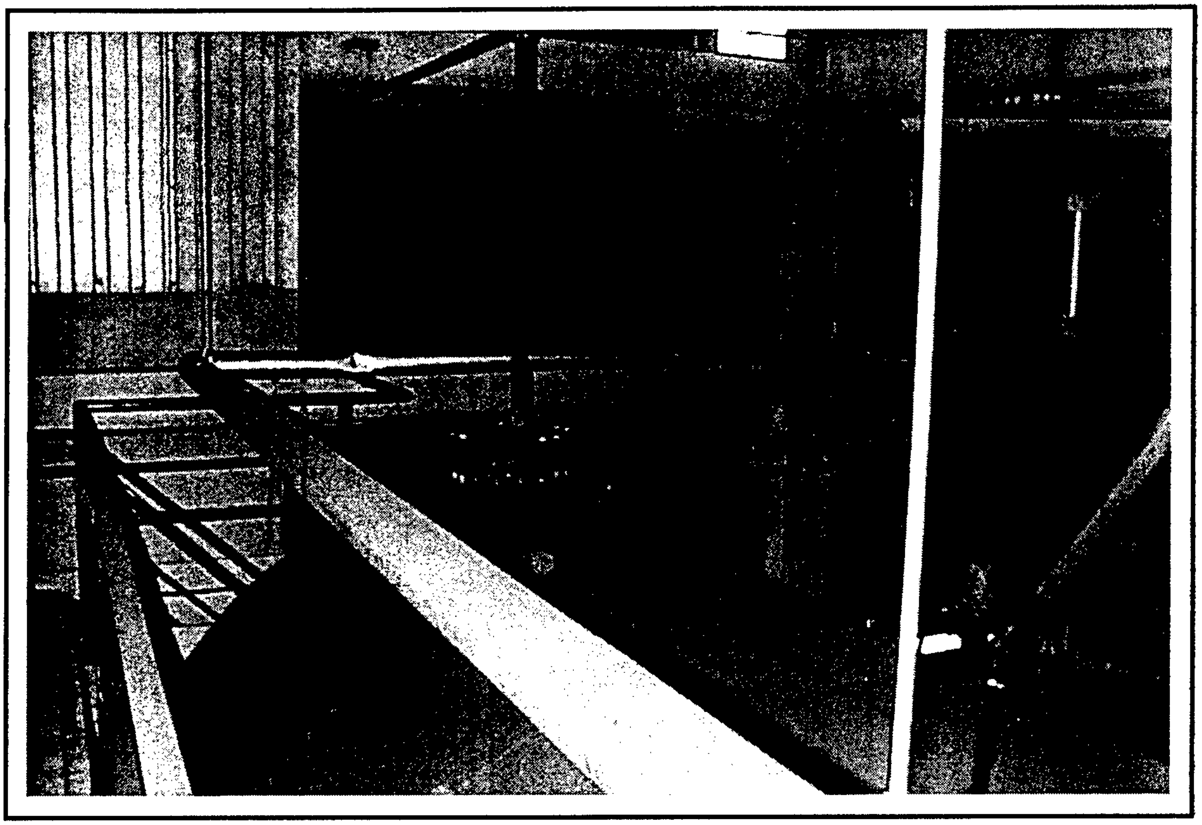

Figure 10. Current blowoff tank bracing.

6 Summary of Recommendations

CERL and SAI recommend the following improvements to WPAFB Plant 1240 pressure controls:

1. Plant 1240 has a computerized plant data recording system that is useful for investigating plant upsets. Unfortunately, system pressure is not recorded as a trend. It is recommended that the screen interface be modified to trend plant pressure and N_2 expansion tank level to help operators and maintainers troubleshoot pressure control problems.
2. Based on code requirements and available information, the team recommends that WPAFB install two "V" safety valves on each HTHW unit. These valves should be sized to relieve the full HTHW unit capacity at 6 percent of the MAWP of 500 psig.
3. To eliminate the HTHW blowoff line water hammer, WPAFB should modify the blowoff valve, piping, and tank configuration. The N_2 tank surge volume is currently undersized. Because of this lack of capacity, operators must discharge water and add makeup water excessively. The least disruptive system modification to alleviate this problem would be to move the blowoff valve to the top of the blowoff tank.

Appendix A: Safety Valve Name Plate Data

Boiler	6	6	5	5	4	4	3	3
Valve	Left	Right	Left	Right	Left	Right	Left	Right
Manufacturer	Teledyne Farris	Longeran	Teledyne Farris	Longeran	Teledyne Farris	Longeran	Consolidated	Consolidated
Other Tag info				Certified Reset Pressure Vessel, 3x4				
Size	4x6	4x6	4x6	4x6	4x6	4x6	3x4	3x4
Type	26NA22-170				26LA22-170			Hidden and unreadable
Model		W306						
Set (psig)		515	515			500	460	
Lift		0.535						
Blowdown		20	36			20		
Seat Dia (in)		2.277						
Capacity	35460		28930		8130?	70212		
Capacity (gpm)	1315		870					
Capacity (lbs/hr)								
Ser Number	68996-A10	770 2328-1-1			82994-A10			
Stamp	UV	V	UV	None!	UV	None!	V	
						Leaking	Leaking	
Repair 1								
Repair Company	Integrated	Integrated	Renew	Renew	Integrated	Integrated	Integrated	
Repair Ser Number	900093-9	9000903-6			9000903-5	9000903-8		
Set Press (psig)	500			500	515	500	500	
Capacity				28672				
Capacity (gpm)				1041				
Capacity (lbs/hr)	99680							
Date of Repair	Sep-98	Sep-98	Nov-98	Nov-98	Sep-98	Sep-98	Sep-98	
Stamp	VR622	VR622	VR 6	None!	VR622	None!		
Repair 1								
Repair Company				Integrated			Renew	
Repair Ser Number								
Set Press (psig)				500				
Capacity								
Capacity (gpm)								
Capacity (lbs/hr)							49680	
Date of Repair				Sep-98			Nov-98	
Stamp				None!				

Appendix B: Safety Valve Body Loading

Article reproduced from the *Seattle Steamer* online publication, by Dan Gentry, located at URL:

http://www.ci.seattle.wa.us/dclu/p64_01.htm

"BOILER PRESSURE EXCEEDED SAFETY VALVE SET PRESSURE BY 100%!"

Safety and relief valve discharge piping can easily be overlooked by both inspectors and boiler operators. I'm not referring to sizing and length in this case although they are of significant importance, but the support of safety and relief valve discharge piping which is something not quite so obvious to the naked eye.

Let's talk steam for a moment. Steam safety valves, when properly tested and maintained, are very reliable safety devices. They are, however, very sensitive to external loading. If I were to thread a ten foot length of pipe into the discharge port of a safety valve and just let it "hang" there with no support, would it affect the operation of the safety valve? Definitely!

I once had a unique opportunity to safely allow a pair of boilers to exceed the set pressure of their safety valves (two were installed). The boilers were 150 psi scotch boilers that had recently been fitted with 50 psi safety valves. During the installation of the new valves, the installer had not properly supported the vertical discharge piping (the safety valve discharge piping included "drip pan ells"). So on with the test. The building engineer "jumpered" the pressure controls and steam pressure began to rise. With the steam pressure at 50 psig, the safety valves remained tightly seated. At 70 psig, the engineer and I looked at each other in amazement. As an inspector looking at a boiler that was steaming at 20 psig above the safety valve set pressure, I had to keep reminding myself that the boilers were good for 150 psig (this helped me fight the urge to run out of the room). Finally, at almost exactly 100 psig, the first safety valve lifted. The second valve lifted shortly after and the engineer restored the boiler controls to the normal configuration. A later test — following proper support of the discharge piping — proved proper safety valve operation.

So, the lesson in this case was that the externally loaded safety valves did not lift until boiler pressure exceeded safety valve set pressure by 100%! The second part of the lesson is that safety valve discharge piping should not only be closely checked at installation, but continuously thereafter. In drip panel installations, the vertical run is often supported by clamps that can weaken or loosen over time. Hard-piped discharges are even more sensitive and their support systems can change over time especially in boiler rooms that tend to heat up and cool down along with the boiler operating cycles.

Take the time to do actual pressure tests of your safety valves (where the boiler pressure is raised to the set pressure of the safety valve) rather than simple lift-lever (manual) tests. While you're at it, continue on and run an accumulation test and see if the "blowdown" of the valve is within tolerance. Afterward, don't be surprised if you feel just a little more comfortable standing in front of that boiler!

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Michael K. Brewer, Charles M. Schmidt, and John Tanner

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13. ABSTRACT *(Maximum 200 words)*

Wright-Patterson AFB (WPAFB) tasked the U.S. Army Construction Engineering Research Laboratory (CERL) to investigate the best way to resolve the problem of incorrect safety valves installed on fired pressure vessels in high temperature hot water (HTHW) generators. Additionally, WPAFB requested help in controlling system pressure in the HTHW system during large load swings, and guidance on how to pipe expansion tank discharge to a blowoff tank.

CERL researchers visited the site, inspected the system, researched relevant specifications, and recommended that: (1) the screen interface for the computerized plant data recording system at Plant 1240 be modified to trend plant pressure and N2 expansion tank level to help troubleshoot pressure control problems, (2) two "V" safety valves be installed on each HTHW unit, and (3) the blowoff valve, piping, and tank configuration be modified to eliminate water hammer.

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