Kansas State University

Steam and Condensate Master Plan

Manhattan, Kansas

Final
March 2013

Stanley Consultants INC.

A Stanley Group Company
Engineering, Environmental and Construction Services - Worldwide

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Executive Summary

General

This Steam and Condensate Master Plan investigates the steam and condensate systems on the campus of Kansas State University (KSU) in Manhattan, Kansas. The University has selected Stanley Consultants to investigate the current campus steam and condensate systems and provide options for growth of these systems as the campus continues to expand in size and number of students. Planning includes short term growth (through year 2017), and long term growth (through the year 2025). Growth projections are described in Section 3, tabulated in Appendix A, and shown graphically on the drawings in Appendix B. The table below shows all building projects expected to be completed and result in additional campus steam load by 2025.

Table ES-1 Building Projects (2025)

Project Name	Add'l Net Area (square feet)	Add'l Steam Load (pph)
Fiedler Hall – Eng Complex Phase IV	80,000	3,530
Justin Hall Expansion	16,376	556
Seaton Hall College of Architecture	125,000	4,243
College of Business Administration	140,000	5,054
Vet-Med Complex	486,968	10,724
Ackert Hall Expansion	76,000	3,676
Cardwell Hall Expansion	16,200	715
Coles Hall Expansion	128,000	6,192
KSU Union Expansion	89,000	2,870
New Classroom Building	66,000	2,383
North of Dickens – New Building	10,000	361

Source: Stanley Consultants, Inc.

Currently, the Power Plant provides an operational steam production capacity of 320,000 pounds per hour and an N+1 capacity of 240,000 pounds per hour. The additional loads from the buildings listed above minus the load of the Kramer Complex (local boilers by 2017) would increase the total load to approximately 206,000 pounds per hour. No additional steam capacity is needed to maintain N+1 reliability through the year 2025.

New Buildings

With the excess capacity of the steam system, new buildings should consider connecting to the loop to avoid the unnecessary cost of local boilers. However, buildings that are not near the existing steam distribution require the additional cost of utility tunnels or buried pipe. The following new building projects are recommended for central steam:

College of Business Administration: A 140,000 square foot classroom building to house the College of Business Administration is planned near the corner of Manhattan Ave. and Lover's Lane. This building could utilize the excess steam capacity from the power plant. However, approximately 700 feet of tunnel would need to be installed to bring the steam to the building at a cost of $2.9 million. Alternatively, geothermal or hybrid-geothermal heating and cooling should be considered. See "Alternative Energy Sources" below. It is recommended to perform Formation Thermal Conductivity Tests (approximately $5,000 to $6,000 per bore) as part of a GSHP study.

Vet-Med Complex: The new Vet-Med Complex includes approximately 323,000 square feet of existing space (Mosier and Trotter) and 164,000 square feet of planned new space. This complex should utilize the excess steam capacity from the power plant. Approximately 1,200 feet of tunnel would need to be installed to bring the steam to the building. The estimated cost for a new 1,200 foot long steam tunnel with a 10" steam main is $5.0 million.

Classroom Building: A 66,000 square foot classroom building is planned to the north of Waters Hall. This is a new building and it should utilize the excess steam capacity from the power plant. Approximately 400 feet of tunnel would need to be installed to bring the steam to the building. The estimated cost for a new 400 foot long steam tunnel with a 6" steam main is $1.7 million. Alternatively, a direct-buried conduit system for steam and condensate could be installed for an estimated $250,000.

North of Dickens – New Building: A 10,000 square foot building is planned to the north of Dickens Hall. This is a new building and it should utilize the excess steam capacity from the power plant. The building is near existing steam mains, so no additional cost (above that of the project) is anticipated.

Cost Estimates

The cost estimates are consistent with a study level of detail. They are not based on a quantity takeoff from a detailed design. Actual costs may vary with the actual scope determined by the design process. Cost estimates are given in 2012 dollars representing present value, do not incorporate inflation, and include margin for undeveloped design details (25%), overhead (15%), profit (10%), and construction contingencies (10%).

Steam Distribution

The University has reduced high pressure steam (HPS) from 225 psig to 150 psig and is in the process of removing PRV stations from the distribution system to allow 150 psig steam to be distributed to each building through existing medium pressure steam (MPS) lines and low pressure steam (LPS) lines. Standardizing on a campus-wide 150 psig building steam supply pressure will help to preserve equipment, simplify the steam distribution system, and improve accessibility to PRV stations. The following items are recommended:

- MPS and LPS systems need to be evaluated for the higher pressure (150 psig) steam prior to removing PRV stations from the distribution system.
- Removing PRV stations from the distribution system to allow 150 psig steam to be distributed to each building through existing MPS lines and LPS lines. Approximate locations are shown on the drawings in Appendix B.
- New PRV stations are to be provided at several buildings, reducing steam pressure from 150 psig to 5 psig. (Certain science buildings and laboratories require 90 psig steam.) Consider using 2-stage, dual-train PRV stations in the buildings. Refer to Appendix D for additional information.

Distribution Piping

In the event of a major steam leak in the distribution piping, the University has limited ability to isolate sections of the steam supply headers without shutting off steam supply to multiple buildings. The addition of a steam tunnel between the Derby and Van Zile dormitory complexes would provide the ability to tie together the East and North Headers, while also being a relatively short distance. This would ensure reliable steam supply while saving money and energy, and would provide more system redundancy than currently exists. The following items are recommended:

- Provide a cross-connection between the North and East steam headers. The estimated cost for a new 600 foot long steam tunnel with a 10” steam main between the Derby and Van Zile dormitory complexes is $2.5 million.
- The campus steam distribution piping and condensate return piping vary in age and condition. It is recommended that the University continue to be proactive in monitoring and replacing aging steam and condensate pipe whenever possible in order to prevent failures before they happen.

Condensate Return

In many instances, condensate return pipe is routed on the floor of the steam tunnel. Routing of the condensate pipe on the floor leaves the pipe and its supports exposed to liquid that may accumulate in the tunnel due to system leaks or tunnel infiltration. It is recommended that when new condensate lines are installed, they be located off the floor to extend the life of the piping.

The University is currently in the process of replacing the electric condensate pumps at the Willard Hall collection site with steam-driven mechanical pump traps. It is recommended that the University continue the replacement of electric condensate pumps with mechanical pump traps in condensate collection systems.

Makeup Water

Currently, there is only one 10" water line to the Power Plant. This lack of redundancy presents a risk if there is a problem with that pipeline. Loss of makeup water poses a threat of steam interruption to campus. It is recommended that the Power Plant have a second main water line installed, supplied by a different city water main than the one currently used.

Utility Tunnels

It is recommended that a full system evaluation be performed on the utility tunnel system. The University should continue to proactively repair tunnels as they near the end of their service lives to prevent future outages or emergencies. Campus personnel indicated the most problematic areas are in the tunnel running parallel to Claflin Road from Mid-Campus Drive to the Derby dormitory complex, and in the tunnel running north from Hale-Farrell Library to Waters Hall. Tunnels near Ackert and Chalmers Halls are also considered problematic due to steam leaks.

Central vs. Local Steam Generation

It is recommended that KSU continue to pursue utilizing the central steam distribution for heating new buildings. A centrally located system is typically more efficient and provides redundancy and reliability across the entire campus. Energy and maintenance costs are also typically lower than utilizing smaller, local units, and with much of the infrastructure already in place (central plant and distribution lines), new buildings can utilize the excess capacity of the power plant by extending branch lines from the mains, to the building. Whether or not it is an economical decision primarily depends on the distance from the mains.

Alternative Energy Sources

Several alternative energy sources for building heating are discussed below. In general, advantages to using alternative energy sources include reduced emissions and improved public relations.

Solar Thermal Energy: Solar thermal can be a cost effective, renewable energy source when utilized in the proper application. From our experience, heating domestic water can be an economical application in the Kansas area for buildings with a consistent and significant DHW load. This requires locating solar panels near the building system, usually on the roof. The appearance of the panels on campus buildings may be a concern. This may be a long term (15+ years payback) investment but will provide energy savings and reduce CO_2 emissions. Individual building studies are recommended to estimate costs and potential savings.

Geothermal Energy: Ground-source heat pumps (GSHPs) use the constant temperature of the earth as the exchange medium instead of the outside air temperature. This ground temperature is warmer than the air above it during the winter and cooler than the air in the summer. The GSHP takes advantage of this by exchanging heat with the earth through a ground heat exchanger. As with any heat pump, GSHPs are able to heat, cool, and, if so equipped, supply the building with hot water.

Hybrid geothermal systems using several different geothermal resources or a combination of a geothermal resource with outdoor air (i.e., a cooling tower), are another technology option.

Hybrid approaches are particularly effective where cooling needs are significantly larger than heating needs.

The installation price of a geothermal system can be several times that of an air-source system of the same heating and cooling capacity. However, the additional costs can be returned in energy savings in 5 to 10 years. System life is estimated at 25 years for the components inside the building and 50+ years for the ground loop.

In order to be cost effective (minimize pumping power requirements), an available open space for the ground loop must be near the building. The space can be a green space, athletic field, or parking lot. A parking lot however, is not a preferred option. One option to pursue at KSU is the space between the planned College of Business Administration and the President's Residence. A ground loop in this area could possibly serve both buildings and avoid the costs of installing a steam tunnel and buried CHW piping. The distance from the central loop to this location improves the cost competitiveness for use of geothermal in this location, as the cost to install a steam tunnel and pipe to the College of Administration building is estimated at $2.9 million.

Another option is the green space between Mid-Campus and Butterfly Drive, which could serve Anderson and Eisenhower Halls. Although these buildings are currently on the central steam loop, the geothermal system would be more energy efficient and would contribute to the cooling load.

The costs of a geothermal system vary greatly depending on several factors including the conductivity of the soil. A slight change in conductivity can significantly impact the performance of the system. It is highly recommended to perform Formation Thermal Conductivity Tests (approximately $5,000 to $6,000 per bore) as part of a GSHP study before proceeding to design.

Outsourcing Utility Systems

As an alternative to utilizing in-house staff for operation and maintenance of the steam production, the work could be outsourced to a contractor who in turn would provide steam to the campus for a fee based on usage. A contract must be set up in a detailed manner and must be written in a manner to protect the university's assets. The contractor may be responsible for the steam plant only, or their scope may include the distribution system also. However the contract is written, an accurate metering system is required.

Outsourcing may relieve the University of their plant O&M responsibilities; however, there are several concerns of which to be aware. Providers are in business to make a profit. They do not always work in the long term best interest of the university. Even if the contract is set up in a very detailed manner, operations and maintenance firms can try to skew the operations and maintenance of the facilities to maximize profits and minimize costs. University staff will still be needed to monitor the work, making sure that contractual agreements are met.

Based on our knowledge of other client experiences, we have found that in most cases universities are dissatisfied with these types of contracts. We recommend KSU continue to operate and maintain their steam production with in-house staff.

Table of Contents

TABLES

FIGURES

APPENDICES

Section 1

Introduction

General

This Steam and Condensate Master Plan investigates the current steam and condensate systems on the campus of Kansas State University (KSU) in Manhattan, Kansas. The University has selected Stanley Consultants to investigate the current campus steam and condensate systems and provide options for growth of these systems as the campus continues to expand in size and number of students. The team will use its expertise to lead the effort to review, revise, and make both tactical and strategic recommendations to support the Steam and Condensate Master Plan development.

Scope

The objective of the Steam and Condensate Master Plan is to develop sufficient information allowing the University to make future utility infrastructure planning decisions related to campus growth; creative solutions, including sustainability considerations; central or satellite utility services; operational efficiencies; life cycle cost of distribution; and reliability.

Project Tasks

This University's Steam and Condensate Master Plan project is broken down into task level requirements:

Task 1

Task 1 is the Site Data Gathering Visit. This includes meeting with the Facilities Management Group of KSU. This data collection effort is critical to the development of the Master Plan. Specific tasks include the following:

- Meet with the facilities staff to identify the existing steam and condensate loads and capacity.

- Site data collection of the existing steam distribution and condensate return systems such as utilities site plans, steam distribution system diagrams, condensate return system diagrams, steam demand loads, and square-footage for each building.
- Review of the present and future projected steam and condensate load capabilities.
- Review of any existing, on-going operational issues with the steam and condensate return systems.

Task 2

Develop a set of overall parameters, constraints, and guidelines for the short term and long term Steam and Condensate Master Plan. Specific tasks include the following:

- Develop a set of parameters for use in Master Plan development. These parameters will include short term and long term items needed to develop effective cost models and methodologies.
- Develop a Master Plan template that can be used for future project evaluation.

Task 3

Prepare a report assessing the existing campus steam and condensate system capacities and conditions and recommendations on the approaches for campus steam production facilities and distribution systems. Specific tasks include the following:

- Summarize current system capacities and future demand requirements.
- Make provisions for anticipated future steam and condensate system loads and expansion.
- Recommend upgrades for the existing utility system to meet present day code requirements if necessary.
- Highlight any “break points” where the University must make substantial capital commitments to meet future demand loads.
- Develop options to meet future system demand.

Section 2

Existing Steam and Condensate Systems

Steam Production

The campus Power Plant is located on 17th Street between the Cooling Plant and Seaton Hall. It is used only for steam production, and no longer generates electricity. It houses seven boilers, five of which are operational. Each boiler is capable of burning natural gas or No.2 fuel oil. Design information for these boilers is taken from field data and the 2010 Facility Conservation Improvement Program report. Design data is summarized in the following table.

Table 2-1 Existing Campus Loop Steam Generators

Name	Manufacturer	Fuel Source	Type	Capacity (kpph)	Condition	Year Installed/ Refurbished
Boiler #1	Nebraska	NG/#2 Oil	Water Tube	20	Operational	2011
Boiler #2	Nebraska	NG/#2 Oil	Water Tube	80	Operational	2004
Boiler #3	Nebraska	NG/#2 Oil	Water Tube	60	Non-Operational	1966
Boiler #4	Nebraska	NG/#2 Oil	Water Tube	80	Operational	2004
Boiler #5	Volcano	NG/#2 Oil	Water Tube	60	Operational	1994
Boiler #6	Nebraska	NG/#2 Oil	Water Tube	80	Operational	2004
Boiler #7	Nebraska	N/A	N/A	N/A	Abandoned	N/A

Source: Stanley Consultants, Inc.

These boilers provide an operational steam production capacity of 320,000 pounds per hour and an N+1 capacity of 240,000 pounds per hour. Campus high pressure steam was supplied as saturated steam at 225 psig; however, this pressure was recently reduced to 150 psig. Boiler #1 was installed in 1966 and was refitted in 2011 with new low capacity, high efficiency equipment, including a new combustion fan, and a new low capacity burner. This boiler is now operated as a “pony boiler” and is meant to increase plant efficiency during periods of low steam load. Also, the superheater in Boiler #1 was removed in 2011. Boilers #3 and #5 each have a superheater; however, superheated steam is no longer produced. Boilers #2, #4, and #6 were installed in 2004, and Boiler #7 is abandoned.

Median service life estimates for various pieces of mechanical equipment are included in Appendix C. The useful service life of all operational boilers is anticipated to last beyond the timeframe of this study. Boiler #3 is at or near the end of its service life and is not currently used or needed.

Pumped condensate is returned from campus to the Power Plant at a temperature of approximately 100-120°F. Makeup water and condensate return are preheated to approximately 170-180°F using economizers prior to entering one of several condensate storage tanks. From here the condensate is transferred to one of two deaerators and into the boiler feedwater system.

Makeup water is provided by a single city water supply to the Power Plant. The water is run through a softener and a reverse osmosis filtration system before entering the basement condensate storage tank. The existing makeup water supply is adequate; however, there is no redundancy. This presents a risk if there is a problem with the city owned water system. Loss of makeup water poses the real threat of steam interruption to campus. It is recommended that the Power Plant have a second main water line installed, supplied by a different city water main than the one currently used.

In the past, makeup water has provided as much as half of the boiler feedwater due to numerous distribution system losses. Steam and condensate leaks result in substantial energy losses, requiring the Power Plant to burn more fuel, and to consume and treat more makeup water. This is inefficient and costly. Recent system improvements and leak repairs have lowered the amount of makeup water used to approximately 28-35%. It is anticipated that this percentage will continue to decrease as more repairs are made. A quality campus steam distribution system with minimal leaks should be able to achieve a makeup quantity less than 20%. However, it is difficult to pinpoint an exact goal as it is unknown what amount of steam and condensate must be lost for use in sterilization or other campus processes. Additionally, as the percentage of makeup water continues to decrease, the quality of condensate return will require more scrutiny to identify contamination issues that could have previously been insignificant.

The Power Plant has two sources of fuel for steam production. Natural gas is supplied by Kansas Gas Service and delivered to the plant via an underground main. This is the primary fuel used in the boilers. The boilers are also capable of burning No.2 fuel oil as a secondary fuel. This is delivered via truck, and stored on site in two 19,550 gallon, underground storage tanks. The No.2 fuel oil storage provides the plant with redundant fuel sources in the event of a supply interruption.

The age and condition of the remaining balance of plant equipment, such as pumps, heat exchangers, tanks, etc. is unknown. Some of this equipment may require replacement or refurbishment within the timeframe of this study and should be evaluated regularly to verify reliable operation. Median service life estimates for various pieces of mechanical equipment are included in Appendix C.

Utility Tunnels

The steam distribution and condensate return systems run throughout the campus in a tunnel system. Nearly all of the tunnels are walkable; however, there are some crawl tunnels. Steam and condensate pipe is also direct buried in some locations; however, these are mostly small lines between buildings such as between McCain Auditorium and Beach Art Museum, or between Burt Hall and Ward Hall.

The tunnels vary in age from new to 80 years old, and the median useful service life of a tunnel is 75 years. The tunnels built in recent years are in good condition while the older tunnels vary in condition from "serviceable" to "in need of repair." Several tunnel locations were toured during the site visit. In some locations, steam and condensate leaks have eroded away large quantities of concrete in the tunnel floor, pipe supports are corroding and failing, and the tunnel ceiling is collapsing. Campus personnel indicated the most problematic areas are in the tunnel running parallel to Claflin Road from Mid-Campus Drive to the Derby dormitory complex, and in the tunnel running north from Hale-Farrell Library to Waters Hall. Tunnels near Ackert and Chalmers Halls are also considered problematic due to steam leaks.

Steam Distribution Piping

The existing steam distribution system consists of two headers; the East Header and North Header. Each of these headers originates at the Power Plant and ultimately ends at the last building on the header, with no cross connections. In the event of a major steam leak, this leaves the University with no ability to isolate sections of the steam supply headers without shutting off steam supply to multiple buildings. The University is left with no other options than to allow the steam line to continue leaking uncontrolled until the system is shut down during summer. Not only does this waste energy, but the schedule for any major system repair is also compressed, as all repairs must be performed in four days during summer shutdown.

Currently, steam leaves the Power Plant saturated at approximately 150 psig. A series of pressure reducing valve (PRV) stations are located at various points in the campus steam supply system. These valve stations ultimately reduce steam pressure to 90 psig and 5 psig depending on individual building needs. Steam was previously generated at 225 psig. The 225 psig steam was hard on valves and other equipment, and the multiple pressure reducing valves complicated the system and increased the amount of maintenance required. However, this high steam pressure was necessary to achieve adequate steam flow to the buildings located furthest from the Power Plant, such as the Veterinary Medicine Complex. This is an indication that there may be bottlenecks or leaks in the steam distribution system. To remedy this, the pressure reducing station at Call Hall was relocated to the Veterinary Medicine Complex.

The University desires to standardize on a campus-wide 150 psig building steam supply pressure and relocate all pressure reducing stations to the individual buildings. This will help to preserve equipment, simplify the steam distribution system, and improve accessibility to PRV stations. A single steam supply pressure will also make potential cross connections easier.

The campus steam distribution piping and condensate return piping vary in age and condition. Under normal use, the service life expectancy of steam distribution piping and condensate return piping is 40 years and 30 years, respectively. As the piping nears the end of its useful life, failures in the system will become more common. However, it is not uncommon for pipe to remain in stable and satisfactory condition for many years after the average age is surpassed. It is recommended that the University continue to be proactive in monitoring and replacing aging steam and condensate pipe whenever possible in order to prevent failures before they happen.

Condensate Return

In many instances, condensate return pipe is routed on the floor of the steam tunnel. This is sometimes necessary in order generate adequate pressure drop to force flow across a steam trap. However, in this system, this would only appear necessary for condensate lines running in parallel with a 5 psig steam line, and may not be necessary at all if steam in the tunnels is converted entirely to 150 psig. Routing of the condensate pipe on the floor leaves the pipe and its supports exposed to liquid that may accumulate in the tunnel due to system leaks or tunnel infiltration. It is recommended that condensate lines be relocated off the floor, wherever possible.

Presently, the condensate return from the buildings is collected in at least two collection sites where condensate is then pumped back to the Power Plant. The condensate collection system below Seaton Hall is in good condition and utilizes fairly new pump traps. An older condensate collection system is located below Willard Hall. It is approximately 50 to 60 years old, and frequently leaks and is in need of replacement.

The University is currently in the process of replacing the electric condensate pumps at the Willard Hall collection site with steam-driven mechanical pump traps. A mechanical pump trap utilizes the pressure of supply steam to force condensate through the condensate return piping and back to the power plant. On average, for every 1,000 pounds of condensate transported, 3 pounds of steam are lost as flash steam at the condensate receiver.

Steam Utilization

Campus steam is used for a variety of building applications including building heating, humidification, sterilization, incubation, process heating, and conversion to hot water via shell and tube heat exchangers. The buildings currently connected to the campus steam distribution and condensate return system are summarized in the following table. Individual peak building steam loads are estimated by comparing building square footage data to historical Power Plant data for steam production. Square footage data is taken from the Building Summary Report created on December 5, 2011 and information provided by KSU. The net square footage for each building was calculated by subtracting the Structural Area (ZZZ) from the total square footage. Individual building metering data is not currently available. A building metering project was recently completed, and in the future, this metering data can be used to verify the accuracy of the building steam load estimates in this report.

Table 2-2 Existing Buildings on Central Steam

Property Name	Net Area (square feet)	Current Header	Steam Load (pph)	Steam Supply Pressure (psig)
Ackert/Chalmers Hall	180,728	North	8,743	150, 90
Ahearn Field House	79,554	North	2,566	90
Anderson Hall	49,795	East	1,690	90
Beach Art Museum	33,839	East	919	90
Bluemont Hall	106,167	East	4,685	90, 5
Boyd Hall	58,656	East	1,742	90, 5
Burt Hall	29,297	North	995	150, 90
Bushnell Hall	19,362	North	937	90, 5
Call Hall	55,190	North	2,436	150
Calvin Hall	43,787	East	1,486	90
Campus Creek Complex	19,401	East	659	90, 5
Cardwell Hall	129,183	North	5,701	150, 90
Chemistry/Biochemistry	85,535	East	4,138	90
Chiller Plant	N/A	North	N/A	150
Coles Hall	93,453	North	4,521	90
Derby Dining Center	83,735	North	4,264	90, 5
Dickens Hall	23,098	East	784	90, 5
Durland/Fiedler/Rathbone Hall	219,238	North	9,675	150
Dykstra Hall	35,396	North	1,051	150, 90
East Stadium	31,064	North	1,002	90
Eisenhower Hall	42,149	East	1,431	90
English/Counseling Services	28,049	East	952	150
Fairchild Hall	44,508	East	1,511	90
Feed Technology	17,059	East	753	90, 5
General Richards B. Meyers Hall	32,288	North	1,096	150, 90
Goodnow Hall	92,584	North	2,750	90, 5
Gymnasium	66,714	North	2,152	90
Hale-Farrell Library	298,814	East	10,144	150
Holton Hall	21,894	East	743	5
Holtz Hall	6,220	East	211	90
Justin Hall	134,287	East	4,559	90, 5
Kedzie Hall	36,925	East	1,253	90
King Hall	37,062	East	1,793	90, 5
Kramer Dining Center	36,334	North	1,850	90, 5
KSU Union	219,378	North	7,075	90
Leasure Hall	28,690	East	974	5
Marlatt Hall	101,488	North	3,015	90, 5
McCain Auditorium	94,176	East	3,037	90

Property Name	Net Area (square feet)	Current Header	Steam Load (pph)	Steam Supply Pressure (psig)
Natatorium	44,528	North	1,436	90
Nichols Hall	55,523	East	2,450	5
President's Residence	7,901	East	134	5
Putnam Hall	57,532	East	1,709	90, 5
Seaton Court	40,145	East	1,363	90
Seaton Hall + Seaton East	218,018	North & East	7,401	90
Shellenberger Hall	44,552	East	1,966	90, 5
Thompson Hall	21,158	East	934	5
Throckmorton Hall	394,712	North	17,419	150
Umberger Hall	40,888	North	1,388	150, 90
Van Zile Hall	55,508	East	1,649	90, 5
Ward Hall	34,304	North	1,165	150, 90
Waters Hall	155,397	East	6,858	90, 5
Waters Hall Annex	14,427	East	637	90, 5
Weber Hall	139,120	North	5,313	90, 5
West Hall	54,190	North	1,610	90, 5
West Stadium	42,216	North	1,361	90
Willard Hall	85,923	East	2,917	90, 5

Source: Stanley Consultants, Inc.

The peak campus steam load totals approximately 161,000 pounds per hour as indicated by historical Power Plant operating data from July 2010 to February 2012. Steam loads of the absorption chillers do not contribute to the peak steam load since the chillers are not used during the heating season. As stated previously, the N+1 steam production capacity is 240,000 pounds per hour. Therefore, the excess steam production capacity is 79,000 pounds per hour. These values indicate that there is more than sufficient capacity available, as campus steam demand could grow nearly 50% before N+1 capacity would be exceeded.

Buildings not currently on the campus steam distribution system use a variety of building heating methods including local boilers, gas furnace, and electric heat. University staff indicated it is not desired to expand the campus steam system to these buildings. Some expansion of buildings currently on the campus steam distribution system is considered in Section 3. A complete list of campus buildings is included in Appendix A, and line sizing, pipe routing, and steam pressures are shown on the drawings in Appendix B.

Section 3

Future Expansion

Steam Production

University staff indicated there is no desire to expand the campus steam system to buildings with local boilers. However, new buildings and expansion projects for buildings currently on the campus steam distribution system are considered in future planning. A complete list of campus buildings is included in Appendix A, and line sizing, pipe routing, and steam pressures are shown on the drawings in Appendix B.

2017 Expansion

Various building and construction projects have been completed or are expected to be completed in the near future. Some of these projects will affect buildings currently on the central steam loop. The following table is a summary of funded building expansion projects expected to be completed by 2017.

Table 3-1 Funded Projects (2017)

Project Name	Add'l Net Area (square feet)	Add'l Steam Load (pph)
Fiedler Hall – Eng Complex Phase IV	80,000	3,530
Justin Hall Expansion	16,376	556
Seaton Hall College of Architecture	125,000	4,243
College of Business Administration	140,000	5,054
Vet-Med Complex	486,968	10,724

Source: Stanley Consultants, Inc.

2025 Expansion

Proposed building expansion projects expected to be completed by 2025 include those listed in the following table.

Table 3-2 Building Projects (2025)

Project Name	Add'l Net Area (square feet)	Add'l Steam Load (pph)
Ackert Hall Expansion	76,000	3,676
Cardwell Hall Expansion	16,200	715
Coles Hall Expansion	128,000	6,192
KSU Union Expansion	89,000	2,870
New Classroom Building	66,000	2,383
North of Dickens – New Building	10,000	361

Source: Stanley Consultants, Inc.

The additional loads from the buildings listed above minus the load of the Kramer Complex (local boilers by 2017) would increase the total load to approximately 206,000 pounds per hour. Refer to the building list provided in Appendix A for further detail.

Steam Distribution

The University desires to standardize on a campus-wide 150 psig building steam supply pressure and relocate all pressure reducing stations to the individual buildings. This will help to preserve equipment, simplify the steam distribution system, and improve accessibility to PRV stations. A single steam supply pressure will also make potential cross connections easier.

Removing PRV stations from the distribution system will allow 150 psig steam to be distributed to each building through existing MPS lines and LPS lines. These lines need to be evaluated for the higher pressure prior to converting to HPS (150 psig). Approximate locations of the PRV stations to be removed from the distribution system are shown on the drawings in Appendix B. These include the following:

- East Header: PRV-A, PRV-B, PRV-C
- North Header: PRV-1, PRV-2, PRV-17

New PRV stations are to be provided inside or near the basement of each building, reducing steam pressure from 150 psig to 5 psig. (Certain science buildings and laboratories require 90 psig steam also.) Existing PRV stations (inside of buildings) have been the subject of complaints due to noise. A large, single pressure drop also reduces the amount of control particularly at low loads. There are several options to consider when specifying a new PRV station. Two-stage PRV stations can reduce noise by reducing to an intermediate pressure before reducing to LPS (5 psig). Other noise reduction options include muffling orifice plates (MOPS) and insulation. Dual-train PRV stations utilize parallel trains, each sized for partial flow (i.e. 1/3 and 2/3 design flow) which allow for the use of smaller valves and provide better control at low loads. The best solution may be different for each building based on factors such as the steam load profile, space constraints, and building occupancy.

Distribution Piping

In the event of a major steam leak in the distribution piping, the University has limited ability to isolate sections of the steam supply headers without shutting off steam supply to multiple buildings. The University will often allow the steam line to continue leaking until the system is shut down during summer. Not only does this waste energy, but the schedule for any major system repair is also compressed.

It is recommended that at least one cross-connection be added to provide redundant steam supply to most buildings. This would ensure reliable steam supply, while saving the money and energy lost due to uncontrolled steam and condensate leaks. It also provides the University with the operational flexibility to isolate sections of the system and make needed repairs without compromising steam delivery to the rest of campus. The addition of a steam tunnel between the Derby and Van Zile dormitory complexes would provide the ability to tie together the East and North Headers, while also being relatively short. This would provide much more system redundancy than currently exists. Due to the presence of sub-headers in the current steam distribution configuration, several local cross-connections would be required to guarantee redundant steam supply to the entire system. Additional cross connections could be added in the future. Depending on system pressure, line size and schedule, part of the existing headers may also need to be up-sized due to potential increases in volumetric flow.

The campus steam distribution piping and condensate return piping vary in age and condition. Under normal use, the service life expectancy of steam distribution piping and condensate return piping is 40 years and 30 years, respectively. As the piping nears the end of its useful life, failures in the system will become more common. However, it is not uncommon for pipe to remain in stable and satisfactory condition for many years after the average age is surpassed. It is recommended that the University continue to be proactive in monitoring and replacing aging steam and condensate pipe whenever possible in order to prevent failures before they happen.

Condensate Return

In many instances, condensate return pipe is routed on the floor of the steam tunnel. This is sometimes necessary in order generate adequate pressure drop to force flow across a steam trap. However, in this system, this would only appear necessary for condensate lines running in parallel with a 5 psig steam line, and may not be necessary at all if steam in the tunnels is converted entirely to 150 psig. Routing of the condensate pipe on the floor leaves the pipe and its supports exposed to liquid that may accumulate in the tunnel due to system leaks or tunnel infiltration. It is recommended that condensate lines be relocated off the floor, wherever possible.

The University is currently in the process of replacing the electric condensate pumps at the Willard Hall collection site with steam-driven mechanical pump traps. A mechanical pump trap utilizes the pressure of supply steam to force condensate through the condensate return piping and back to the power plant. On average, for every 1,000 pounds of condensate transported, 3 pounds of steam are lost as flash steam at the condensate receiver. There are several benefits to using a mechanical pump trap:

- Inefficiencies associated with a centrifugal pump and electrical motor are eliminated.
- Installation costs are low as no electrical work is required.
- Pump traps are more compact.
- The issue of cavitation encountered with centrifugal pumping of condensate is eliminated.

It is recommended that the University continue the replacement of electrical, centrifugal pumps with mechanical pump traps in condensate collection systems where practical.

Makeup Water

The existing water supply for the Power Plant originates from a city main north of Pat Roberts Hall. The branch line is metered and runs south along Denison Avenue, west at Claflin, and south along 17th Street to the plant. There is a second branch connection from the city main that runs south along Manhattan Avenue and west along Claflin to 17th Street. This line is connected to, but normally closed off from the 17th Street line to the plant. Refer to the drawings in Appendix B.

Since there is only one 10” water line to the Power Plant, there is no redundancy. This presents a risk if there is a problem with that pipeline. Loss of makeup water poses the real threat of steam interruption to campus. It is recommended that the Power Plant have a second main water line installed, supplied by a different city water main than the one currently used.

Utility Tunnels

It is recommended that a full system evaluation be performed on the utility tunnel system. The University should continue to proactively repair tunnels as they near the end of their service lives to prevent future outages or emergencies. Campus personnel indicated the most problematic areas are in the tunnel running parallel to Claflin Road from Mid-Campus Drive to the Derby dormitory complex, and in the tunnel running north from Hale-Farrell Library to Waters Hall. Tunnels near Ackert and Chalmers Halls are also considered problematic due to steam leaks. Under normal circumstances, the engineering required for a new tunnel installation or tunnel replacement will take 9 to 12 months with a construction period of 12 to 18 months, depending on the length of the tunnel. The engineering required for repair of tunnel sections typically takes 1 to 2 months, depending on the severity of damage and repair requirements.

Overview

Currently, the Power Plant provides an operational steam production capacity of 320,000 pounds per hour and an N+1 capacity of 240,000 pounds per hour.

It is anticipated that the steam load will increase to 190,000 pounds per hour by 2017 and to 206,000 pounds per hour by the year 2025. No additional steam capacity is needed to maintain N+1 reliability through the year 2025. An additional 1.3 million square-feet of building space has been proposed for beyond 2025. The existing plant can accommodate an additional building heating space of approximately 850,000 square-feet beyond 2025 while maintaining N+1 capacity.

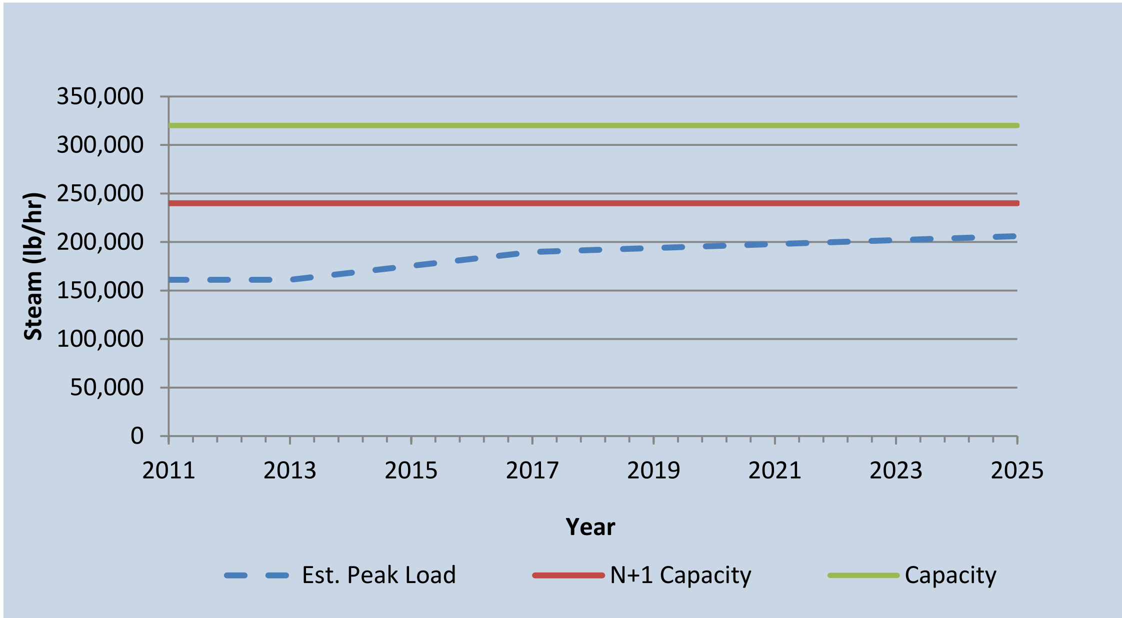

Figure 3-1: Steam Load vs. Capacity

To summarize, several opportunities for improvement were identified in the existing steam distribution and condensate return system. These are listed below.

- Remove PRV stations from the distribution system to allow HPS (150 psig) to be distributed throughout campus to all buildings on the steam loop.
- Install dual-train, two-stage pressure reducing stations in buildings to reduce 150 psig steam to 5 psig quietly and effectively. Individual building steam studies may be required to determine the best option for each building.
- Install a cross-connection in the steam distribution system between Derby and Van Zile dormitory complexes. This will provide a redundant steam supply to several buildings as well as provide operational flexibility to make online repairs.
- Continue to proactively monitor and replace aging steam and condensate pipe in order to prevent failures before they happen.
- Relocate condensate return lines off of the tunnel floor.
- Install a second water main to the Power Plant to provide redundancy and reduce the threat of steam interruption to campus.
- Regularly evaluate balance of plant equipment, such as pumps, heat exchangers, tanks, etc. to verify reliable operation.
- Replace condensate collection systems as needed, incorporating mechanical pump traps in place of electrical centrifugal pumps where practical.
- Perform a full system evaluation of the utility tunnel system and continue to proactively repair tunnels as they near the end of their service lives to prevent future outages or emergencies.

- Utilize building metering data to verify the individual building steam load estimates in this report.

Section 4

Recommendations

Steam System Summary

Currently, the Power Plant provides an operational steam production capacity of 320,000 pounds per hour and an N+1 capacity of 240,000 pounds per hour.

It is anticipated that the steam load will increase to 190,000 pounds per hour by 2017 and to 206,000 pounds per hour by the year 2025. No additional steam capacity is needed to maintain N+1 reliability through the year 2025.

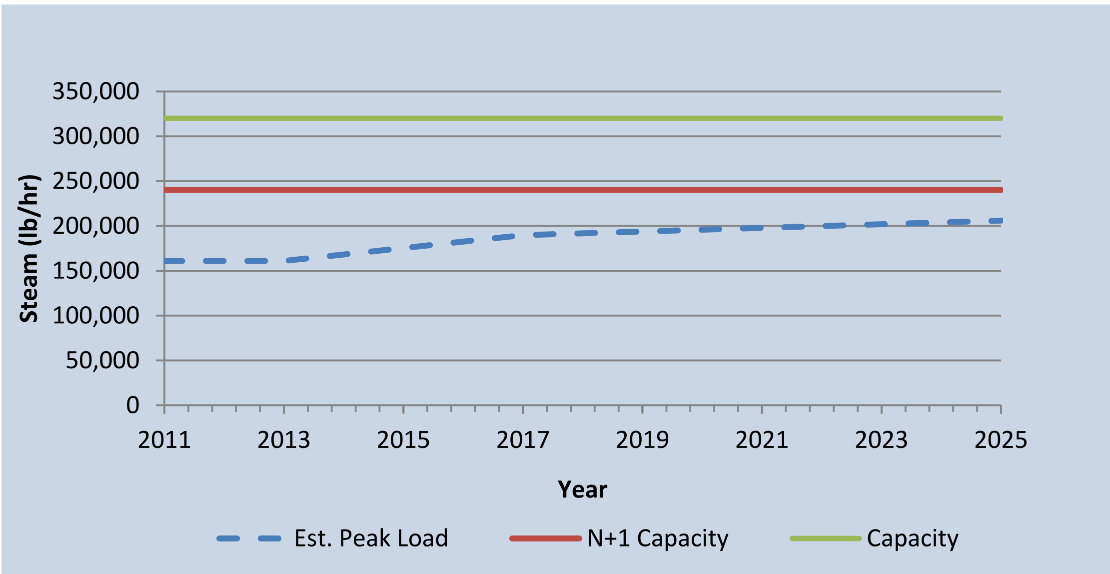

Figure 4-1: Steam Load vs. Capacity

Steam Distribution

The University should continue to remove PRV stations from the distribution system to allow 150 psig steam to be distributed to each building through existing MPS lines and LPS lines. These lines need to be evaluated for the higher pressure prior to converting to HPS (150 psig). Approximate locations of the PRV stations to be removed from the distribution system are shown on the drawings in Appendix B. These include the following:

- East Header: PRV-A, PRV-B, PRV-C
- North Header: PRV-1, PRV-2, PRV-17

New PRV stations are to be provided inside or near the basement of each building, reducing steam pressure from 150 psig to 5 psig. (Certain science buildings and laboratories require 90 psig steam also.) Existing PRV stations (inside of buildings) have been the subject of complaints due to noise. A large, single pressure drop also reduces the amount of control particularly at low loads. There are several options to consider when specifying a new PRV station. Two-stage PRV stations can reduce noise by reducing to an intermediate pressure before reducing to LPS (5 psig). Other noise reduction options include muffling orifice plates (MOPS) and insulation. Dual-train PRV stations utilize parallel trains, each sized for partial flow (i.e. 1/3 and 2/3 design flow) which allow for the use of smaller valves and provide better control at low loads. The best solution may be different for each building based on factors such as the steam load profile, space constraints, and building occupancy. Refer to Appendix D for preliminary vendor information for a few sample buildings.

Distribution Piping

It is recommended that at least one cross-connection be added to provide redundant steam supply to most buildings. The addition of a steam tunnel between the Derby and Van Zile dormitory complexes would provide the ability to tie together the East and North Headers, while also being a relatively short distance. The estimated cost for a new 600 foot long steam tunnel with a 10" steam main is $2.5 million.

Additional cross connections could be added in the future. Depending on system pressure, line size and schedule, part of the existing headers may also need to be up-sized due to potential increases in volumetric flow.

Condensate Return

Continue the process of replacing the electric condensate pumps at the Willard Hall collection site with steam-driven mechanical pump traps. There are several benefits to using a mechanical pump trap:

- Inefficiencies associated with a centrifugal pump and electrical motor are eliminated.
- Installation costs are low as no electrical work is required.
- Pump traps are more compact.
- The issue of cavitation encountered with centrifugal pumping of condensate is eliminated.

It is recommended that the University continue the replacement of electrical, centrifugal pumps with mechanical pump traps in condensate collection systems where practical.

Makeup Water

Currently, there is only one 10” water line to the Power Plant. This lack of redundancy presents a risk if there is a problem with that pipeline. Loss of makeup water poses a threat of steam interruption to campus. It is recommended that the Power Plant have a second main water line installed, supplied by a different city water main than the one currently used.

Utility Tunnels

It is recommended that a full system evaluation be performed on the utility tunnel system. The University should continue to proactively repair tunnels as they near the end of their service lives to prevent future outages or emergencies. Campus personnel indicated the most problematic areas are in the tunnel running parallel to Claflin Road from Mid-Campus Drive to the Derby dormitory complex, and in the tunnel running north from Hale-Farrell Library to Waters Hall. Tunnels near Ackert and Chalmers Halls are also considered problematic due to steam leaks.

Continue to proactively monitor and replace aging steam and condensate pipe in order to prevent failures before they happen, and relocate condensate return lines off of the tunnel floor.

Cost Estimates

The cost estimates are consistent with a study level of detail. They are not based on a quantity takeoff from a detailed design. Actual costs may vary with the actual scope determined by the design process. Cost estimates are given in 2012 dollars representing present value and do not incorporate inflation. Cost estimates given below include margin for undeveloped design details (25%), overhead (15%), profit (10%), and construction contingencies (10%).

Current Projects

Ackert Hall: An expansion of 76,000 square feet is planned for Ackert Hall. This building currently utilizes steam from the central plant. The expansion project should utilize steam from the central plant also. No additional cost (above that of the expansion) is anticipated.

Cardwell Expansion: An expansion of 16,200 square feet is planned for Cardwell Hall. This building currently utilizes steam from the central plant. The expansion project should utilize steam from the central plant also. No additional cost (above that of the expansion) is anticipated.

Classroom Building: A 66,000 square foot classroom building is planned to the north of Waters Hall. This is a new building and it should utilize the excess steam capacity from the power plant. Approximately 400 feet of tunnel would need to be installed to bring the steam to the building. The estimated cost for a new 400 foot long steam tunnel with a 6” steam main is $1.7 million. Alternatively, a direct-buried conduit system for steam and condensate could be installed for an estimated $250,000.

Coles Expansion: An expansion of 128,000 square feet is planned for Coles Hall. This building currently utilizes steam from the central plant. The expansion project should utilize steam from the central plant also. No additional cost (above that of the expansion) is anticipated.

College of Business Administration: A 140,000 square foot classroom building to house the College of Business Administration is planned near the corner of Manhattan Ave. and Lover's Lane. This is a new building and it should utilize the excess steam capacity from the power plant. Approximately 700 feet of tunnel would need to be installed to bring the steam to the building. The estimated cost for a new 700 foot long steam tunnel with an 8" steam main is $2.9 million.

Fiedler Hall, Engineering Complex Phase IV: An expansion of 80,000 square feet is planned for the Phase IV building of the Engineering Complex. The engineering complex buildings currently utilize steam from the central plant. The expansion project should utilize steam from the central plant also. No additional cost (above that of the expansion) is anticipated.

Justin Hall: An expansion of 16,376 square feet is planned for Justin Hall. This building currently utilizes steam from the central plant. The expansion project should utilize steam from the central plant also. No additional cost (above that of the expansion) is anticipated.

Kramer Complex: Kramer, Marlatt, and Goodnow are currently on the north loop. The renovation of this complex will provide local boilers and remove this load from central steam system.

KSU Union Expansion: An expansion of 89,000 square feet is planned for the KSU Union. This building currently utilizes steam from the central plant. The expansion project should utilize steam from the central plant also. No additional cost (above that of the expansion) is anticipated.

North of Dickens – New Building: A 10,000 square foot building is planned to the north of Dickens Hall. This is a new building and it should utilize the excess steam capacity from the power plant. The building is near existing steam mains, so no additional cost (above that of the project) is anticipated.

Seaton Hall College of Architecture: Seaton Hall and Seaton East include 218,018 square feet of administration and classroom space. The College of Architecture expansion will add 125,000 square feet of space. This building currently utilizes steam from the central plant. The expansion project should utilize steam from the central plant also. No additional cost (above that of the expansion) is anticipated.

Vet-Med Complex: in addition to the addition to Coles Hall, the new Vet-Med Complex includes approximately 323,000 square feet of existing space (Mosier and Trotter) and 164,000 square feet of planned new space. This complex should utilize the excess steam capacity from the power plant. Approximately 1,200 feet of tunnel would need to be installed to bring the steam to the building. The estimated cost for a new 1,200 foot long steam tunnel with a 10" steam main is $5.0 million.

Overview

To summarize, several opportunities for improvement were identified in the existing steam distribution and condensate return system. These are listed below.

- Continue to remove PRV stations from the distribution system to allow HPS (150 psig) to be distributed throughout campus to all buildings on the steam loop.

- Install dual-train, two-stage pressure reducing stations in buildings to reduce 150 psig steam to 5 psig quietly and effectively. Individual building steam studies may be required to determine the best option for each building.
- Install a cross-connection in the steam distribution system between Derby and Van Zile dormitory complexes. This will provide a redundant steam supply to several buildings as well as provide operational flexibility to make online repairs.
- Continue replacement of condensate collection systems as needed, incorporating mechanical pump traps in place of electrical centrifugal pumps where practical.
- Perform a full system evaluation of the utility tunnel system and continue to proactively repair tunnels as they near the end of their service lives to prevent future outages or emergencies.
- Continue to proactively monitor and replace aging steam and condensate pipe in order to prevent failures before they happen.
- Relocate condensate return lines off of the tunnel floor.
- Install a second water main to the Power Plant to provide redundancy and reduce the threat of steam interruption to campus.
- Regularly evaluate balance of plant equipment, such as pumps, heat exchangers, tanks, etc. to verify reliable operation.
- Utilize building metering data to verify the individual building steam load estimates in this report.

Respectfully submitted,

Stanley Consultants, Inc.

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Feasibility Disclaimer

All recommendations and/or advice presented in this document are Stanley Consultants' opinions of probable project conditions. Project conditions are based on the information and data sources that are readily available to us, input by the client, and other reliable sources, all of which are believed to be accurate. Our recommendations and/or advice are made on the basis of our experience and represent our judgment and opinions. We have no control over new and/or non-public information, changed conditions, cost of land, cost of labor, materials, equipment, and/or other construction costs, or over competitive bidding or market conditions. Therefore, we do not guarantee that actual conditions or actual costs will not vary from those presented in this report, study, plan, etc.

"Cost Estimates" Disclaimer

All cost estimates presented in this report are Stanley Consultants' opinions of probable project, construction, and/or operation and maintenance costs. Costs estimates are made on the basis of our experience and represent our best judgment. We have no control over cost of labor, materials, equipment, contractor's methods, or over competitive bidding or market conditions. Therefore, we do not guarantee that proposals, bids, or actual construction costs will not vary from estimates of project costs, construction, and/or operation and maintenance costs presented. The estimates do not include inflation.

Appendix A

Building List

Kansas State University
Building List
Proposed Steam Distribution

3/7/2013

					2011 Data						Proposed for 2017						Proposed for 2025						
Property Code	Sheet No.	Property Name	Occupancy Type	Year Constructed	Steam System	Net Area (sq-ft)	Peak Flow (lb/hr)	Peak Load (MMBtu /hr)	Supply Pressure (psig)	Line Size (inches)	Steam System	Net Area (sq-ft)	Peak Flow (lb/hr)	Peak Load (MMBtu /hr)	Supply Pressure (psig)	Line Size (inches)	Steam System	Net Area (sq-ft)	Peak Flow (lb/hr)	Peak Load (MMBtu /hr)	Supply Pressure (psig)	Line Size (inches)	Notes:
AK/AKC	2	Ackert/Chalmers Hall	LABS	1970/2002	North	180,728	8,743	9.9	150, 90	6", ?	North	180,728	8,743	9.9	150, 90	6", ?	North	256,728	12,419	14.0	150, 90	6", ?	Addition of 76,000 sf by 2025.
AFH	1	Ahearn Field House	GYM/FIELDHOUSE	1951	North	79,554	2,566	2.9	90	8"	North	79,554	2,566	2.9	90	8"	North	79,554	2,566	2.9	90	8"	
A	1	Anderson Hall	ADMIN/CLASS	1879	East	49,795	1,690	1.9	90	3"	East	49,795	1,690	1.9	90	3"	East	49,795	1,690	1.9	90	3"	
BA	1	Beach Art Museum	MUSEUM	1996	East	33,839	919	1.0	90	?	East	33,839	919	1.0	90	?	East	33,839	919	1.0	90	?	
BH	1	Bluemont Hall	SCIENCE	1981	East	106,167	4,685	5.3	90, 5	1.5", ?	East	106,167	4,685	5.3	90, 5	1.5", ?	East	106,167	4,685	5.3	90, 5	1.5", ?	
BD	2	Boyd Hall	DORM	1951	East	58,656	1,742	2.0	90, 5	2", 6"	East	58,656	1,742	2.0	90, 5	2", 6"	East	58,656	1,742	2.0	90, 5	2", 6"	
BT	1	Burt Hall	ADMIN/CLASS	1923	North	29,297	995	1.1	150, 90	1.5", 1.5"	North	29,297	995	1.1	150, 90	1.5", 1.5"	North	29,297	995	1.1	150, 90	1.5", 1.5"	
BU	2	Bushnell Hall	LABS	1949	North	19,362	937	1.1	90, 5	1", 4"	North	19,362	937	1.1	90, 5	1", 4"	North	19,362	937	1.1	90, 5	1", 4"	
CL	2	Call Hall	SCIENCE	1963	North	55,190	2,436	2.7	150	10"	North	55,190	2,436	2.7	150	10"	North	55,190	2,436	2.7	150	10"	
C	1	Calvin Hall	ADMIN/CLASS	1908	East	43,787	1,486	1.7	90	3"	East	43,787	1,486	1.7	90	3"	East	43,787	1,486	1.7	90	3"	
ER	1	Campus Creek Complex	ADMIN/CLASS	1949	East	19,401	659	0.7	90, 5	2", 2.5", 3", 1"	East	19,401	659	0.7	90, 5	2", 2.5", 3", 1"	East	19,401	659	0.7	90, 5	2", 2.5", 3", 1"	
CW	2	Cardwell Hall	SCIENCE	1963	North	129,183	5,701	6.4	150, 90	2", 4"	North	129,183	5,701	6.4	150, 90	2", 4"	North	145,383	6,416	7.2	150, 90	2", 4"	Planned expansion of 16,200 sq-ft assumed by 2025.
CB	1	Chemistry/Biochemistry	LABS	1988	East	85,535	4,138	4.7	90	4"	East	85,535	4,138	4.7	90	4"	East	85,535	4,138	4.7	90	4"	
PP	1	Chiller Plant	PLANT		North		0		150	6"	North				150	6"	North				150	6"	
VMS	2	Coles Hall	LABS	1972	North	93,453	4,521	5.1	90	12"	North	93,453	4,521	5.1	90	12"	North	221,453	10,713	12.1	90	12"	Planned expansion of 128,000 sq-ft assumed by 2025.
DF	2	Derby Dining Center	RESTAURANT	Unknown	North	83,735	4,264	4.8	90, 5	4", 12"	North	83,735	4,264	4.8	90, 5	4", 12"	North	83,735	4,264	4.8	90, 5	4", 12"	
D	1	Dickens Hall	ADMIN/CLASS	1908	East	23,098	784	0.9	90, 5	1.5", 5"	East	23,098	784	0.9	90, 5	1.5", 5"	East	23,098	784	0.9	90, 5	1.5", 5"	
DU/DUF/DUR	1	Durland/Fiedler/Rathbone Hall	SCIENCE	1976/1982/2000	North	219,238	9,675	10.9	150	4"	North	299,238	13,206	14.9	150	4"	North	299,238	13,206	14.9	150	6"	Planned Engineering Complex Phase IV addition (80,000 sq-ft) assumed by 2017.
DY	2	Dykstra Hall	SHOP/OFFICE	1955	North	35,396	1,051	1.2	150, 90	1.5", 2"	North	35,396	1,051	1.2	150, 90	1.5", 2"	North	35,396	1,051	1.2	150, 90	1.5", 2"	
ES	1	East Stadium	AUDITORIUM	1928	North	31,064	1,002	1.1	90	3"	North	31,064	1,002	1.1	90	3"	North	31,064	1,002	1.1	90	3"	Welcome Center 2012.
EH	1	Eisenhower Hall	ADMIN/CLASS	1951	East	42,149	1,431	1.6	90	3", 3"	East	42,149	1,431	1.6	90	3", 3"	East	42,149	1,431	1.6	90	3", 3"	
ECS	1	English/Counseling Services	ADMIN/CLASS	1960	East	28,049	952	1.1	150	10"	East	28,049	952	1.1	150	10"	East	28,049	952	1.1	150	10"	Possible demolition.
F	1	Fairchild Hall	ADMIN/CLASS	1894	East	44,508	1,511	1.7	90	3"	East	44,508	1,511	1.7	90	3"	East	44,508	1,511	1.7	90	3"	
FT	2	Feed Technology	SCIENCE	Unknown	East	17,059	753	0.8	90, 5	1.25", 6"	East	17,059	753	0.8	90, 5	1.25", 6"	East	17,059	753	0.8	90, 5	1.25", 6"	
MS	2	General Richards B. Meyers Hall	ADMIN/CLASS	1943	North	32,288	1,096	1.2	150, 90	1.5", 2"	North	32,288	1,096	1.2	150, 90	1.5", 2"	North	32,288	1,096	1.2	150, 90	1.5", 2"	
GD	2	Goodnow Hall	DORM	1960	North	92,584	2,750	3.1	90, 5	1.5", 10"													Will have local boilers by 2017.
GY	1	Gymnasium	GYM/FIELDHOUSE	Unknown	North	66,714	2,152	2.4	90	See AFH	North	66,714	2,152	2.4	90	See AFH	North	66,714	2,152	2.4	90	See AFH	
HL	1	Hale-Farrell Library	LIBRARY	1927/1970/1997	East	298,814	10,144	11.4	150	10"	East	298,814	10,144	11.4	150	10"	East	298,814	10,144	11.4	150	10"	
HH	1	Holton Hall	ADMIN/CLASS	1900/1989	East	21,894	743	0.8	5	?	East	21,894	743	0.8	5	?	East	21,894	743	0.8	5	?	
HZ	1	Holtz Hall	ADMIN/CLASS	1876	East	6,220	211	0.2	90	3"	East	6,220	211	0.2	90	3"	East	6,220	211	0.2	90	3"	
JU	1	Justin Hall	ADMIN/CLASS	1960/2010	East	134,287	4,559	5.1	90, 5	4", 12"	East	150,663	5,115	5.8	90, 5	4", 12"	East	150,663	5,115	5.8	90, 5	4", 12"	Planned expansion of 16,376 sq-ft assumed by 2017.
K	1	Kedzie Hall	ADMIN/CLASS	1897	East	36,925	1,253	1.4	90	3"	East	36,925	1,253	1.4	90	3"	East	36,925	1,253	1.4	90	3"	
KG	1	King Hall	LABS	1966	East	37,062	1,793	2.0	90, 5	2", 6"	East	37,062	1,793	2.0	90, 5	2", 6"	East	37,062	1,793	2.0	90, 5	2", 6"	
KF	1	Kramer Dining Center	RESTAURANT	1960	North	36,334	1,850	2.1	90, 5	2", 6"													Will have local boilers by 2017.
UN	1	KSU Union	MULTI-USE	1956/1995	North	219,378	7,075	8.0	90	4"	North	219,378	7,075	8.0	90	4"	North	308,378	9,945	11.2	90	4"	Addition of 89,000 sf by 2025.
LS	1	Leasure Hall	ADMIN/CLASS	1908	East	28,690	974	1.1	5	6"	East	28,690	974	1.1	5	6"	East	28,690	974	1.1	5	6"	
ML	2	Marlatt Hall	DORM	1964	North	101,488	3,015	3.4	90, 5	2.5", 10"													Will have local boilers by 2017.
M	1	McCain Auditorium	AUDITORIUM	1970	East	94,176	3,037	3.4	90	6"	East	94,176	3,037	3.4	90	6"	East	94,176	3,037	3.4	90	6"	
NA	1	Natatorium	GYM/FIELDHOUSE	1975	North	44,528	1,436	1.6	90	See AFH	North	44,528	1,436	1.6	90	See AFH	North	44,528	1,436	1.6	90	See AFH	
N	1	Nichols Hall	SCIENCE	1985	East	55,523	2,450	2.8	5	6"	East	55,523	2,450	2.8	5	6"	East	55,523	2,450	2.8	5	6"	
PR	1	President's Residence	RESIDENCE	1922	East	7,901	134	0.2	5	2.5"	East	7,901	134	0.2	5	2.5"	East	7,901	134	0.2	5	2.5"	
PU	2	Putnam Hall	DORM	1951	East	57,532	1,709	1.9	90, 5	2", 6"	East	57,532	1,709	1.9	90, 5	2", 6"	East	57,532	1,709	1.9	90, 5	2", 6"	
SC	1	Seaton Court	ADMIN/CLASS	1874/1977	East	40,145	1,363	1.5	90	8"	East	40,145	1,363	1.5	90	8"	East	40,145	1,363	1.5	90	8"	
S	1	Seaton Hall + Seaton East	ADMIN/CLASS	1909/1922/1959	North & East	218,018	7,401	8.3	90	6"	North & East	343,018	11,644	13.1	90	6"	North & East	343,018	11,644	13.1	90	6"	College of Architecture addition of 125,000 sf by 2017.
SH	2	Shellenberger Hall	SCIENCE	1960	East	44,552	1,966	2.2	90, 5	2.5", 8"	East	44,552	1,966	2.2	90, 5	2.5", 8"	East	44,552	1,966	2.2	90, 5	2.5", 8"	
T	1	Thompson Hall	SCIENCE	1922	East	21,158	934	1.1	5	?	East	21,158	934	1.1	5	?	East	21,158	934	1.1	5	?	
TH	2	Throckmorton Hall	SCIENCE	1981/1994	North	394,712	17,419	19.6	150	6", 6", 6", 6"	North	394,712	17,419	19.6	150	6", 6", 6", 6"	North	394,712	17,419	19.6	150	6", 6", 6", 6"	
UM	2	Umberger Hall	ADMIN/CLASS	1956	North	40,888	1,388	1.6	150, 90	1.5", 1.25"	North	40,888	1,388	1.6	150, 90	1.5", 1.25"	North	40,888	1,388	1.6	150, 90	1.5", 1.25"	

Kansas State University
Building List
Proposed Steam Distribution

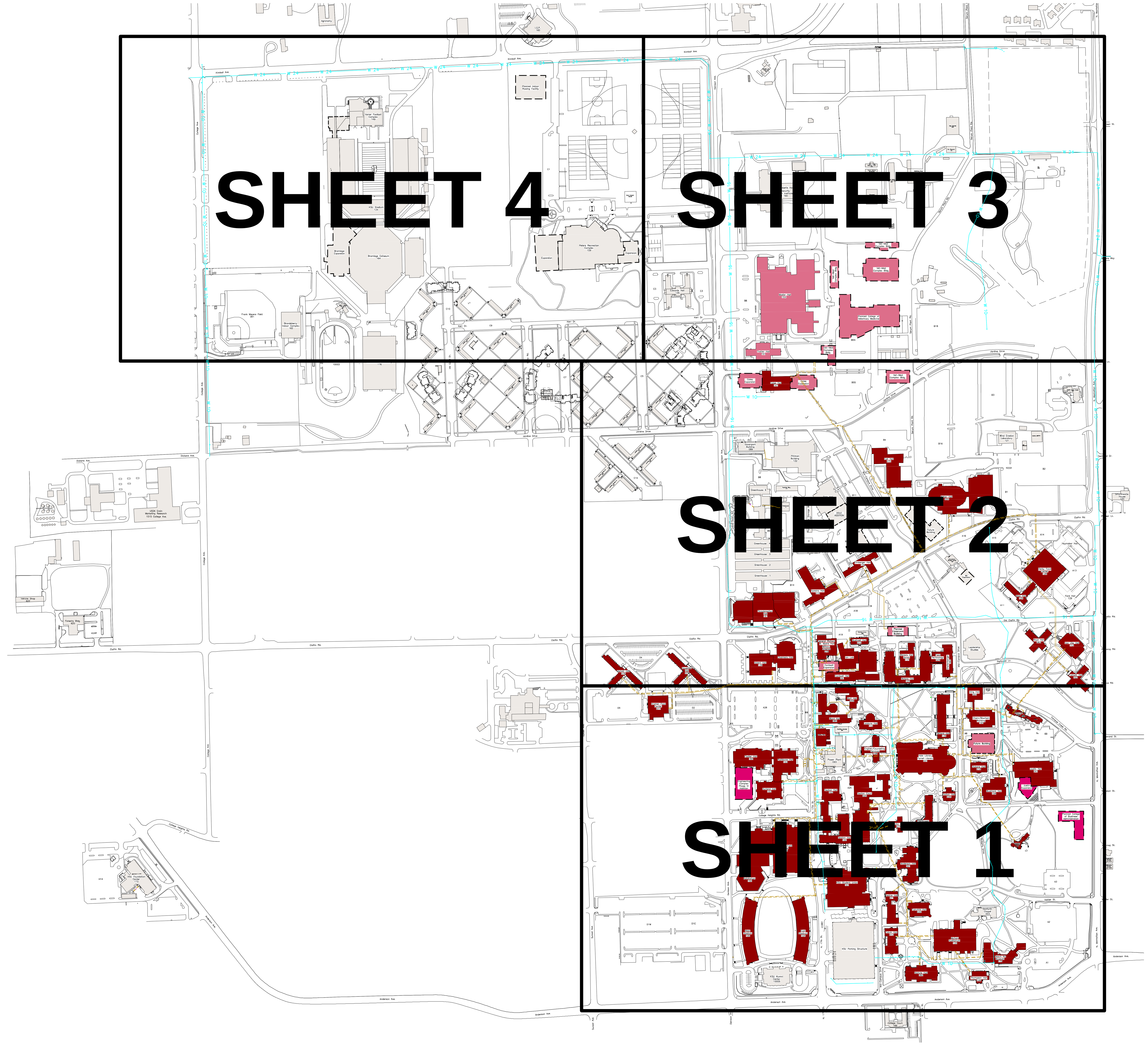
					2011 Data						Proposed for 2017						Proposed for 2025						
Property Code	Sheet No.	Property Name	Occupancy Type	Year Constructed	Steam System	Net Area (sq-ft)	Peak Flow (lb/hr)	Peak Load (MMBtu /hr)	Supply Pressure (psig)	Line Size (inches)	Steam System	Net Area (sq-ft)	Peak Flow (lb/hr)	Peak Load (MMBtu /hr)	Supply Pressure (psig)	Line Size (inches)	Steam System	Net Area (sq-ft)	Peak Flow (lb/hr)	Peak Load (MMBtu /hr)	Supply Pressure (psig)	Line Size (inches)	Notes:
VZ	2	Van Zile Hall	DORM	1926	East	55,508	1,649	1.9	90, 5	2", 6"	East	55,508	1,649	1.9	90, 5	2", 6"	East	55,508	1,649	1.9	90, 5	2", 6"	
WD	1	Ward Hall	ADMIN/CLASS	1961/1972	North	34,304	1,165	1.3	150, 90	6", 4"	North	34,304	1,165	1.3	150, 90	6", 4"	North	34,304	1,165	1.3	150, 90	6", 4"	
WA	2	Waters Hall	SCIENCE	1923/1964	East	155,397	6,858	7.7	90, 5	2.5", 8"	East	155,397	6,858	7.7	90, 5	2.5", 8"	East	155,397	6,858	7.7	90, 5	2.5", 8"	
WAX	2	Waters Hall Annex	SCIENCE	Unknown	East	14,427	637	0.7	90, 5	3/4", 4"	East	14,427	637	0.7	90, 5	3/4", 4"	East	14,427	637	0.7	90, 5	3/4", 4"	
WB	2	Weber Hall	AUD/SCIENCE	1988	North	139,120	5,313	6.0	90, 5	4", 10"	North	139,120	5,313	6.0	90, 5	4", 10"	North	139,120	5,313	6.0	90, 5	4", 10"	
WH	2	West Hall	DORM	1967	North	54,190	1,610	1.8	90, 5	4", 16"	North	54,190	1,610	1.8	90, 5	4", 16"	North	54,190	1,610	1.8	90, 5	4", 16"	
WS	1	West Stadium	AUDITORIUM	1938	North	42,216	1,361	1.5	90	3"	North	42,216	1,361	1.5	90	3"	North	42,216	1,361	1.5	90	3"	Theater in West Stadium 2012.
W	1	Willard Hall	ADMIN/CLASS	1939	East	85,923	2,917	3.3	90, 5	1.5", 8"	East	85,923	2,917	3.3	90, 5	1.5", 8"	East	85,923	2,917	3.3	90, 5	1.5", 8"	
	1	College of Business	ADMIN/CLASS	Planned							East	140,000	5,054	5.6	150	4"	East	140,000	5,054	5.6	150	4"	New 140,000 sf building.
	2	Vet-Med Complex																					
VCS	3	Mosier Hall	LABS	Unknown							North	239,128	12,302	13.6	150	6"	North	239,128	12,302	13.6	150	6"	
VMT	3	Trotter Hall	ADMIN/CLASS	1973							North	83,840	3,027	3.4	150	3"	North	83,840	3,027	3.4	150	3"	
	3	Other	SCIENCE	Planned							North	164,000	7,697	8.5	150	4"	North	164,000	7,697	8.5	150	4"	
	2	Classroom Building	ADMIN/CLASS	Planned													North	66,000	2,383	2.6	150	3"	New 66,000 sf building.
	1	North of Dickens - New Building	ADMIN/CLASS	Planned													East	10,000	361	0.4	150	3"	New 10,000 sf building.
AC	1	Alumni Center	AUDITORIUM	2002																			
KFS	4	Bill Snyder Family Stadium	GYM/FIELDHOUSE	1968																			Local boilers.
BC	4	Bramlage Coliseum	AUDITORIUM	1988																			Local boilers.
BR	4	Brandeberry Indoor Complex	GYM/FIELDHOUSE	1980																			Local boilers.
BUX	2	Bushnell Annex	LABS	Unknown																			Possible demolition.
CCD	3	Center for Child Development	CHILD CARE	2010																			Possible demolition for Research Building.
REC	4	Chester E. Peters Recreation Complex	GYM/FIELDHOUSE	1980/1995/2012																			Local boilers.
CC	N/A	College Court	ADMIN/CLASS	Unknown																			
DC	1	Danforth and All Faiths Chapels	CHURCH	1949																			
DV	2	Davenport Building	SHOP/OFFICE	Unknown																			
DO	2	Dole Hall	ADMIN/CLASS	1991																			
ED	3	Edwards Hall	ADMIN/CLASS	1968																			
EXF	N/A	Extension Forestry	SHOP/OFFICE	Unknown																			
FG	1	Facilities Grounds	SHOP/OFFICE	Unknown																			
FS	2	Facilities Shops	SHOP/OFFICE	Unknown																			
FSB	2	Facilities Storage Building	WAREHOUSE	Unknown																			
FD	2	Ford Hall	DORM	1967																			
FMF	4	Frank Meyers Field	GYM/FIELDHOUSE	1955																			Local boilers.
GHD	2	Greenhouse D Conservatory	SCIENCE	1907																			
HB	3	Handball Building	GYM/FIELDHOUSE	Unknown																			
HY	2	Haymaker Hall	DORM	1967																			
HST	2	Hoeflin Stone House	LABS	Unknown																			
IPF	4	Indoor Practice Facility	GYM/FIELDHOUSE	1995																			Local boilers.
	4	Indoor Rowing Facility	GYM/FIELDHOUSE	Proposed																			Local boilers.
ISC	2	International Student Center	ADMIN/CLASS	1977																			
JT	2/3/4	Jardine Apartments	APARTMENTS	Various																			
GM	2	K-State Gardens Maintenance	SHOP	Unknown																			
KPS	1	K-State Parking Structure	OFFICE	2010																			
LSP	2	Leadership Studies Building	ADMIN/CLASS	2011																			
MO	2	Moore Hall	DORM	1967																			
BRI	3	Pat Roberts Hall	LABS	Unknown																			Local boilers.
PFS	2	Physical Facilities Storage	SHOP/OFFICE	Unknown																			
PH	2	Pittman Building	WAREHOUSE	1967																			
PP	1	Power Plant	OFFICE	1928																			
SB	N/A	UFM Community Learning Center	ADMIN/CLASS	1960																			
VFO	4	Vanier Football Complex	GYM/FIELDHOUSE	1972/2007																			Local boilers.
WEL	2	Wind Erosion Laboratory	LABS	Unknown																			
		TOTALS				**4,221,139**	**161,000**	**181.6**				**4,839,077**	**189,795**	**213.5**				**5,224,277**	**205,993**	**231.7**			

Appendix B

Drawings

Stanley Consultants INC.

NORTH



GENERAL SYSTEM IMPROVEMENTS

- RELOCATE ALL CONDENSATE RETURN LINES OFF TUNNEL FLOOR, WHERE POSSIBLE.
- PROACTIVELY MONITOR AND REPLACE AGING STEAM AND CONDENSATE PIPE TO AVOID FAILURES.

LEGEND

HPS	HIGH PRESSURE STEAM (150 psig)
MPS	MEDIUM PRESSURE STEAM (90 psig)
LPS	LOW PRESSURE STEAM (5 psig)
	2011 STEAM LOOP
	2017 STEAM LOOP
	2025 STEAM LOOP
	PLANNED BUILDING
	EXISTING STEAM TUNNEL
STM	EXISTING DIRECT BURIED STEAM PIPING
W	EXISTING WATER MAIN
	ABANDONED STEAM TUNNEL

KANSAS STATE UNIVERSITY – STEAM AND CONDENSATE KEY PLAN

CADD 04-R3
24034.01.00-\\CHG-FS1\PRJ-PRIVATE\KANSAS_STATE_UNIVERSITY\2403401\ACTIVE\11-CADD\KSU_STM_KEY_PLAN.DWG

KANSAS STATE UNIVERSITY – STEAM AND CONDENSATE MASTER PLAN SHEET 1

24034.01.00-\\CHG-FS1\PRJ-PRIVATE\KANSAS_STATE_UNIVERSITY\2403401\ACTIVE\11-CADD\KSU_STM_PLAN_1.DWG

Stanley Consultants INC.

SEE SHEET 3 FOR CONTINUATION

SEE SHEET 1 FOR CONTINUATION

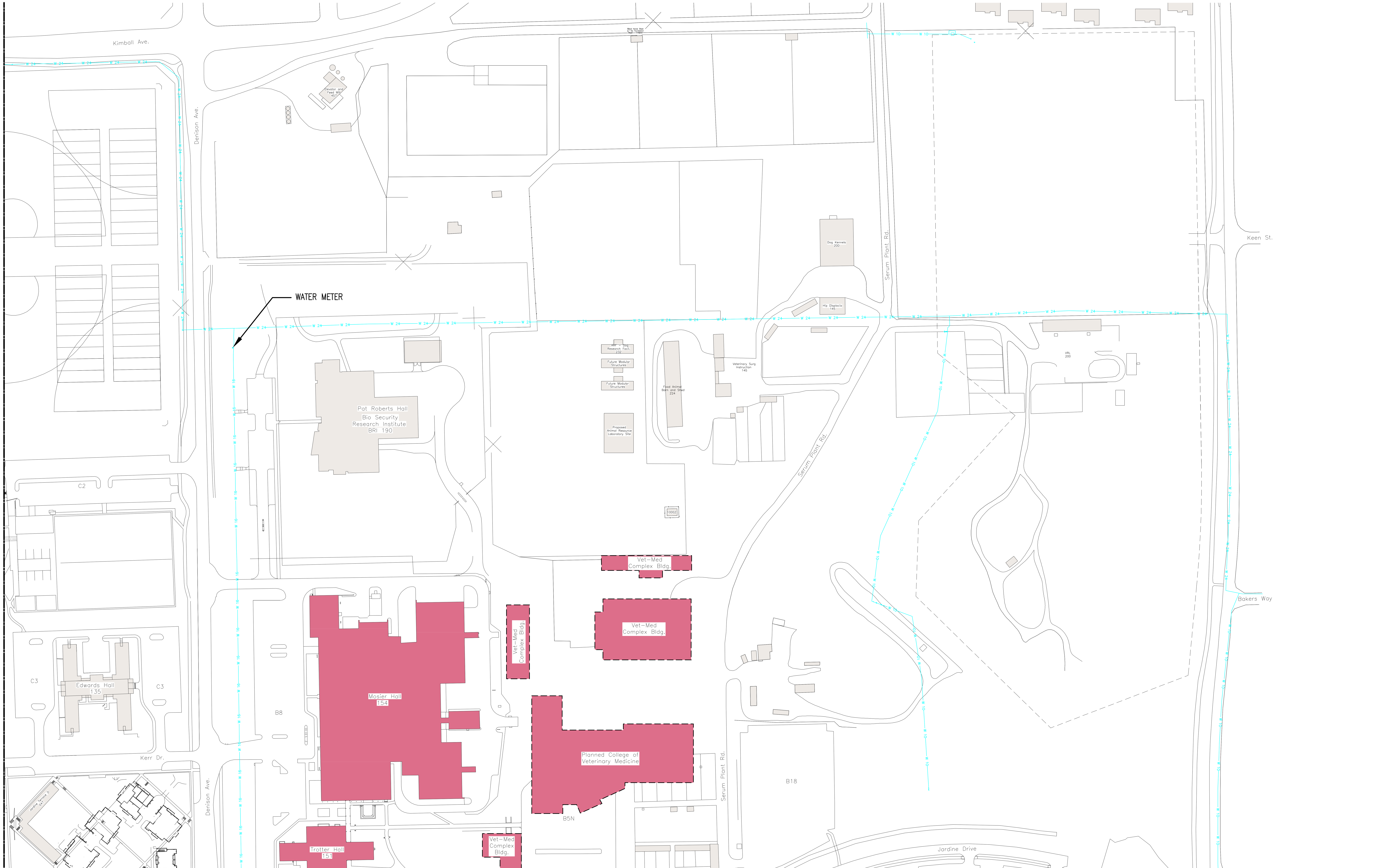
KANSAS STATE UNIVERSITY – STEAM AND CONDENSATE MASTER PLAN SHEET 2

24034.01.00–\\CHG-FS1\PRJ-PRIVATE\KANSAS_STATE_UNIVERSITY\24034.01\ACTIVE\11-CADD\KSU_STM_PLAN_2.DWG

CADD D4-R3

Stanley Consultants INC.

NORTH



SEE SHEET 4 FOR CONTINUATION

SEE SHEET 2 FOR CONTINUATION

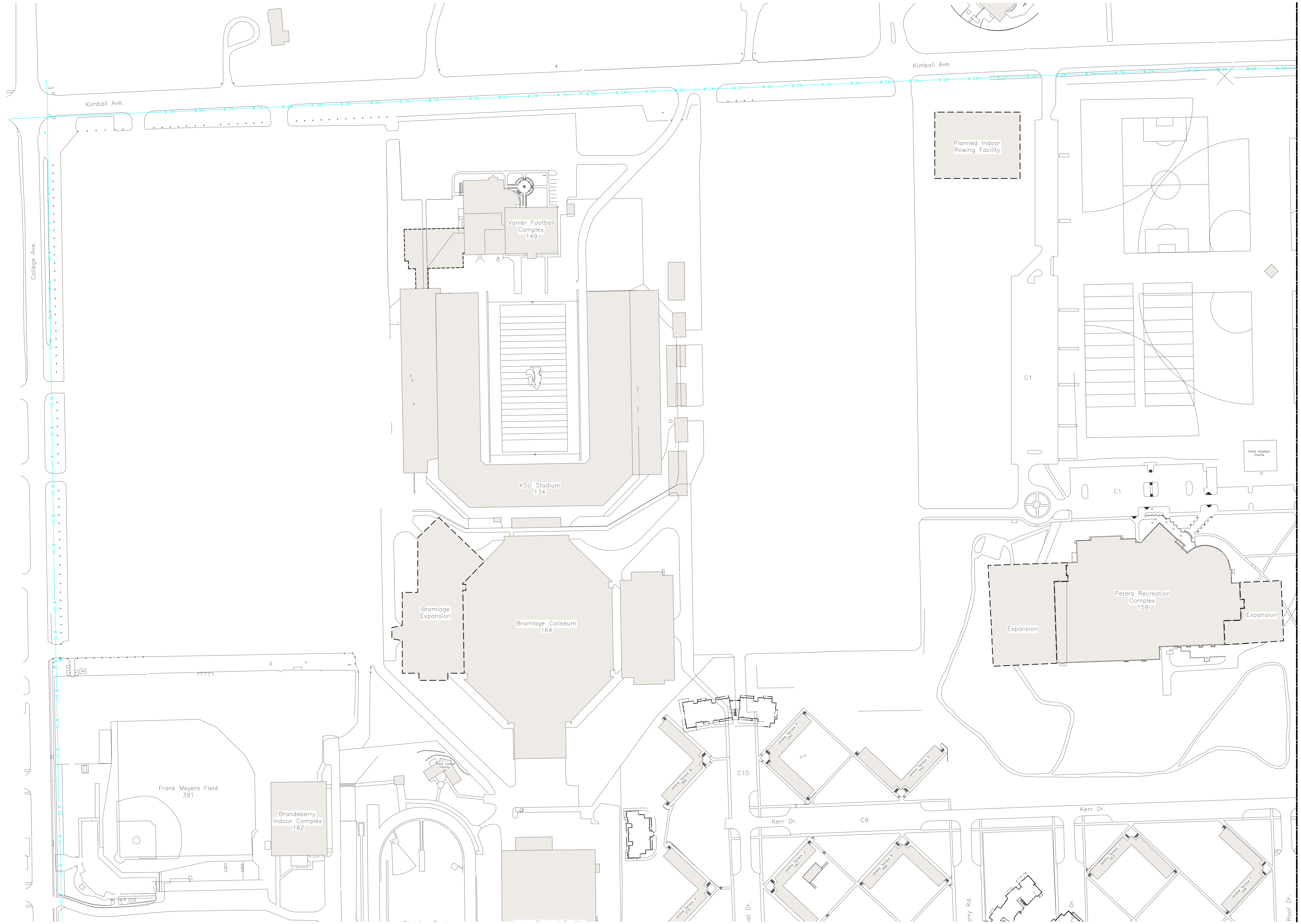
KANSAS STATE UNIVERSITY – STEAM AND CONDENSATE MASTER PLAN SHEET 3

24034.01.00–\\CHG–FS1\PRJ–PRIVATE\KANSAS_STATE_UNIVERSITY\2403401\ACTIVE\11–CADD\KSU_STM_PLAN_3.DWG

CADD 04–R3

Stanley Consultants INC.

NORTH



SEE SHEET 3 FOR CONTINUATION

KANSAS STATE UNIVERSITY – STEAM AND CONDENSATE PLAN SHEET 4

CADD D4-R3
24034.01.00-\\CHG-FS1\PRJ-PRIVATE\KANSAS_STATE_UNIVERSITY\2403401\ACTIVE\11-CADD\KSU_STM_PLAN_4.DWG

Appendix C

Equipment Service Life

Equipment Service Life

Steam and Hot Water Systems	**Service Life**
Boilers (water tube)	40 years
Boilers (fire tube)	25 years
Heat Exchangers (shell and tube)	24 years
Pumps (condensate)	15 years
Pumps (pipe mounted)	20 years
Pumps (base mounted)	20 years
Condensers (air cooled)	20 years
Steam Turbines	30 years
Centrifugal Fans	25 years
Axial Fans	20 years
Pre-Insulated Underground piping	40 years
Pre-Insulated Underground piping (condensate)	30 years
Tunnels	75 years
Chilled Water Systems	
Packaged Chillers (centrifugal)	35 years
Absorption Chillers (steam)	23 years
Cooling Towers (galvanized metal - SS)	23 years
Replace Fill at 10-15 years.	
Cooling Towers (ceramic)	34 years
Condensers (evaporative)	20 years
Condensers (air cooled)	12-15 years
Pumps (base mounted)	20 years
Pumps (pipe mounted)	20 years
Fans (centrifugal)	25 years
Fans (axial)	20 years
Chilled Water Piping	50 years

Appendix D

Pressure Reducing Valve Stations

Vendor Information

The following sheets include preliminary vendor solutions to PRV stations for a few sample buildings. These are for reference only.

WATTS INDUSTRIES, INC.
SPENCE ENGINEERING COMPANY, INC.
150 COLDENHAM ROAD, WALDEN, NY 12586-2035 | (914) 778-5566 | FAX: (914) 778-1072

Project:
Location: **Ackert Chalmers**
Tag: **1st stage- 1/3**

User Defined

Selected Valve: **E** , Size: **1 1/4"**, Seat Factor: **FULL**, **STANDARD VALVE**
Required CV=**13.30**, Actual CV=**14.10**, @ **94%** capacity P2=**113.6** (psig)

2" Orifice Plate (**1** holes @ **1-5/16**) CV=**18.51** P3/P2=**.816**
Inlet velocity: **12720** ft/min Outlet velocity: **16284** ft/min P2/P1=**.779**
Delivery Line is: **2"**, SCH **40** pipe @ **8906** ft/min
Estimated Noise: **75.8** dBA Safety Valve Relief pressure: **105.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **2664** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
3:25:03 PM

Required STEAM flow 2883 lbs/hr
Inlet pressure 150 psig
Reduced pressure 90 psig
Relief Valve Set Pressure 105 psig
Degrees Superheat 0.0 °F
Steam Temperature 366.0 °F
Standard Valves Y

Spence Engineering accepts no responsibility for the sizing solutions that are provided by this program, as actual operations conditions often vary. It is the user's responsibility to verify all application information. The sizing solutions that are provided by this program do not take into account the valve materials selection. Selection of valve material is dictated by the service conditions of temperature and pressure.

WATTS INDUSTRIES, INC.
SPENCE ENGINEERING COMPANY, INC.
150 COLDENHAM ROAD, WALDEN, NY 12586-2035 I (914) 778-5566 I FAX: (914) 778-1072

Project:
Location: **Ackert Chalmers**
Tag: **1st stage 2/3**

Engineered w/Noise Supression

Selected Valve: **E** , Size: **2"**, Seat Factor: **FULL**, **STANDARD VALVE**
Required CV=**26.97**, Actual CV=**31.00**, @ **87%** capacity P2=**113.4** (psig)

4" Orifice Plate (**9** holes @ **5/8**) CV=**37.77** P3/P2=**.817**
Inlet velocity: **11524** ft/min Outlet velocity: **14772** ft/min P2/P1=**.778**
Delivery Line is: **4"**, SCH **40** pipe @ **4772** ft/min
Estimated Noise: **78.8** dBA Safety Valve Relief pressure: **105.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **5692** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
3:25:37 PM

Required STEAM flow 5860 lbs/hr
Inlet pressure 150 psig
Reduced pressure 90 psig
Relief Valve Set Pressure 105 psig
Degrees Superheat 0.0 °F
Steam Temperature 366.0 °F
Standard Valves Y

Spence Engineering accepts no responsibility for the sizing solutions that are provided by this program, as actual operations conditions often vary. It is the user's responsibility to verify all application information. The sizing solutions that are provided by this program do not take into account the valve materials selection. Selection of valve material is dictated by the service conditions of temperature and pressure.

WATTS INDUSTRIES, INC.

SPENCE ENGINEERING COMPANY, INC.

150 COLDENHAM ROAD, WALDEN, NY 12586-2035 | (914) 778-5566 | FAX: (914) 778-1072

Project:
Location: **Ackert Chalmers**
Tag: **2nd stage 1/3**

User Defined

Selected Valve: **E** , Size: **1 1/2"**, Seat Factor: **FULL**, **STANDARD VALVE**
Required CV=**16.25**, Actual CV=**19.80**, @ **82%** capacity P2=**47.1** (psig)

4" Orifice Plate (**9** holes @ **17/32**) CV=**27.29** P3/P2=**.318**
Inlet velocity: **14680** ft/min Outlet velocity: **23742** ft/min P2/P1=**.590**
Delivery Line is: **4"**, SCH **40** pipe @ **10918** ft/min
Estimated Noise: **75.7** dBA Safety Valve Relief pressure: **15.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **3249** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
3:28:09 PM

Required STEAM flow 2883 lbs/hr
Inlet pressure 90 psig
Reduced pressure 5 psig
Relief Valve Set Pressure 15 psig
Degrees Superheat 0.0 °F
Steam Temperature 331.0 °F
Standard Valves Y

Spence Engineering accepts no responsibility for the sizing solutions that are provided by this program, as actual operations conditions often vary. It is the user's responsibility to verify all application information. The sizing solutions that are provided by this program do not take into account the valve materials selection. Selection of valve material is dictated by the service conditions of temperature and pressure.

WATTS INDUSTRIES, INC.

SPENCE ENGINEERING COMPANY, INC.

150 COLDENHAM ROAD, WALDEN, NY 12586-2035 | (914) 778-5566 | FAX: (914) 778-1072

Project:
Location: **Ackert Chalmers**
Tag: **2nd stage 2/3**

User Defined

Selected Valve: **E** , Size: **2 1/2"**, Seat Factor: **FULL**, **STANDARD VALVE**
Required CV=**33.38**, Actual CV=**44.00**, @ **75%** capacity P2=**48.3** (psig)

6" Orifice Plate (**9** holes @ **3/4**) CV=**54.40** P3/P2=**.312**
Inlet velocity: **12688** ft/min Outlet velocity: **20117** ft/min P2/P1=**.602**
Delivery Line is: **6"**, SCH **40** pipe @ **9778** ft/min
Estimated Noise: **78.5** dBA Safety Valve Relief pressure: **15.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **6861** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
3:26:18 PM

Required STEAM flow 5860 lbs/hr
Inlet pressure 90 psig
Reduced pressure 5 psig
Relief Valve Set Pressure 15 psig
Degrees Superheat 0.0 °F
Steam Temperature 331.0 °F
Standard Valves Y

Spence Engineering accepts no responsibility for the sizing solutions that are provided by this program, as actual operations conditions often vary. It is the user's responsibility to verify all application information. The sizing solutions that are provided by this program do not take into account the valve materials selection. Selection of valve material is dictated by the service conditions of temperature and pressure.

Project:
Location: **Gymnasium**
Tag: **1st stage with NO MOP**

Most Economical

Selected Valve: **E** , Size: **1"**, Seat Factor: **FULL**, **STANDARD VALVE**
Required CV=**8.06**, Actual CV=**8.80**, @ **92%** capacity P2=**90.0** (psig)

Inlet velocity: **16432** ft/min Outlet velocity: **25812** ft/min P2/P1=**.636**
Delivery Line is: **1 1/4"**, SCH **40** pipe @ **14915** ft/min
Estimated Noise: **82.0** dBA Safety Valve Relief pressure: **105.0** (psig)
Safety Relief Valve (steam regulator only) **2090** lbs/hr MINIMUM
Design guidelines have been removed for this selection!

Raw Input . . . .

Steam Regulator
January 15, 2013
3:32:46 PM

Required STEAM flow 2152 lbs/hr
Inlet pressure 150 psig
Reduced pressure 90 psig
Relief Valve Set Pressure 105 psig
Degrees Superheat 0.0 °F
Steam Temperature 366.0 °F
Standard Valves Y

Spence Engineering accepts no responsibility for the sizing solutions that are provided by this program, as actual operations conditions often vary. It is the user's responsibility to verify all application information. The sizing solutions that are provided by this program do not take into account the valve materials selection. Selection of valve material is dictated by the service conditions of temperature and pressure.

WATTS INDUSTRIES, INC.

SPENCE ENGINEERING COMPANY, INC.

150 COLDENHAM ROAD, WALDEN, NY 12586-2035 I (914) 778-5566 I FAX: (914) 778-1072

Project:
Location: **Gymnasium**
Tag: **1st stage with MOP**

Engineered w/Noise Supression

Selected Valve: **E** , Size: **1 1/4"**, Seat Factor: **NORMAL**, **STANDARD VALVE**
Required CV=**9.34**, Actual CV=**10.40**, @ **89%** capacity P2=**108.1** (psig)

1 1/4" Orifice Plate (**1** holes @ **1-7/32**) CV=**15.96** P3/P2=**.852**
Inlet velocity: **9494** ft/min Outlet velocity: **12655** ft/min P2/P1=**.746**
Delivery Line is: **1 1/4"**, SCH **40** pipe @ **14915** ft/min
Estimated Noise: **72.6** dBA Safety Valve Relief pressure: **105.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **2069** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
3:33:28 PM

Required STEAM flow 2152 lbs/hr
Inlet pressure 150 psig
Reduced pressure 90 psig
Relief Valve Set Pressure 105 psig
Degrees Superheat 0.0 °F
Steam Temperature 366.0 °F
Standard Valves Y

Spence Engineering accepts no responsibility for the sizing solutions that are provided by this program, as actual operations conditions often vary. It is the user's responsibility to verify all application information. The sizing solutions that are provided by this program do not take into account the valve materials selection. Selection of valve material is dictated by the service conditions of temperature and pressure.

WATTS INDUSTRIES, INC.

SPENCE ENGINEERING COMPANY, INC.

150 COLDENHAM ROAD, WALDEN, NY 12586-2035 | (914) 778-5566 | FAX: (914) 778-1072

Project:
Location: **Gymnasium 2 nd stage**
Tag: **2nd stage**

User Defined

Selected Valve: **E** , Size: **1 1/4"**, Seat Factor: **FULL**, **STANDARD VALVE**
Required CV=**12.02**, Actual CV=**14.10**, @ **85%** capacity P2=**42.0** (psig)

3" Orifice Plate (**4** holes @ **23/32**) CV=**22.20** P3/P2=**.347**
Inlet velocity: **14915** ft/min Outlet velocity: **26110** ft/min P2/P1=**.542**
Delivery Line is: **3"**, SCH **40** pipe @ **14033** ft/min
Estimated Noise: **74.1** dBA Safety Valve Relief pressure: **15.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **2443** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
3:31:42 PM

Required STEAM flow 2152 lbs/hr
Inlet pressure 90 psig
Reduced pressure 5 psig
Relief Valve Set Pressure 15 psig
Degrees Superheat 0.0 °F
Steam Temperature 331.0 °F
Standard Valves Y

Spence Engineering accepts no responsibility for the sizing solutions that are provided by this program, as actual operations conditions often vary. It is the user’s responsibility to verify all application information. The sizing solutions that are provided by this program do not take into account the valve materials selection. Selection of valve material is dictated by the service conditions of temperature and pressure.

WATTS INDUSTRIES, INC.
SPENCE ENGINEERING COMPANY, INC.
150 COLDENHAM ROAD, WALDEN, NY 12586-2035 | (914) 778-5566 | FAX: (914) 778-1072

Project: throckmorton
Location:
Tag: 1st stage 1/3

User Defined

Selected Valve: **E** , Size: **2"**, Seat Factor: **FULL, STANDARD VALVE**
Required CV=**27.79**, Actual CV=**31.00**, @ **89%** capacity P2=**117.3** (psig)

4" Orifice Plate (**9** holes @ **19/32**) CV=**34.09** P3/P2=**.793**
Inlet velocity: **11308** ft/min Outlet velocity: **14080** ft/min P2/P1=**.801**
Delivery Line is: **4"**, SCH **40** pipe @ **4682** ft/min
Estimated Noise: **76.4** dBA Safety Valve Relief pressure: **100.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **5692** lbs/hr MINIMUM

PLATE & PIPE SIZE INCREASED TO OBTAIN NECESSARY CAPACITY

Raw Input . . . .

Steam Regulator
January 15, 2013
2:20:44 PM

Required STEAM flow 5750 lbs/hr
Inlet pressure 150 psig
Reduced pressure 90 psig
Relief Valve Set Pressure 100 psig
Degrees Superheat 0.0 °F
Steam Temperature 366.0 °F
Standard Valves Y

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WATTS INDUSTRIES, INC.

SPENCE ENGINEERING COMPANY, INC.

150 COLDENHAM ROAD, WALDEN, NY 12586-2035 | (914) 778-5566 | FAX: (914) 778-1072

Project: throckmorton
Location:
Tag: 1st stage 2/3

User Defined

Selected Valve: **E** , Size: **3"**, Seat Factor: **FULL, STANDARD VALVE**
Required CV=**56.59**, Actual CV=**74.00**, @ **76%** capacity P2=**117.5** (psig)

5" Orifice Plate (**9** holes @ **27/32**) CV=**68.84** P3/P2=**.792**
Inlet velocity: **10417** ft/min Outlet velocity: **12946** ft/min P2/P1=**.803**
Delivery Line is: **5"**, SCH **40** pipe @ **6047** ft/min
Estimated Noise: **79.8** dBA Safety Valve Relief pressure: **100.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **12509** lbs/hr MINIMUM

PLATE & PIPE SIZE INCREASED TO OBTAIN NECESSARY CAPACITY

Raw Input . . . .

Steam Regulator
January 15, 2013
2:19:23 PM

Required STEAM flow 11670 lbs/hr
Inlet pressure 150 psig
Reduced pressure 90 psig
Relief Valve Set Pressure 100 psig
Degrees Superheat 0.0 °F
Steam Temperature 366.0 °F
Standard Valves Y

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Project: throckmorton
Location:
Tag: 2nd stage 1/3

User Defined

Selected Valve: **E** , Size: **2"**, Seat Factor: **FULL, STANDARD VALVE**
Required CV=**27.93**, Actual CV=**31.00**, @ **90%** capacity P2=**43.9** (psig)

4" Orifice Plate (**9** holes @ **23/32**) CV=**49.95** P3/P2=**.336**
Inlet velocity: **15446** ft/min Outlet velocity: **26293** ft/min P2/P1=**.559**
Delivery Line is: **4"**, SCH **40** pipe @ **18935** ft/min
Estimated Noise: **78.7** dBA Safety Valve Relief pressure: **15.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **5419** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
2:15:55 PM

Required STEAM flow 5000 lbs/hr
Inlet pressure 90 psig
Reduced pressure 5 psig
Relief Valve Set Pressure 15 psig
Degrees Superheat 0.0 °F
Steam Temperature 331.0 °F
Standard Valves Y

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Project: throckmorton
Location:
Tag: 2nd stage 2/3

User Defined

Selected Valve: **E** , Size: **3"**, Seat Factor: **FULL, STANDARD VALVE**
Required CV=**63.85**, Actual CV=**74.00**, @ **86%** capacity P2=**46.4** (psig)

6" Orifice Plate (**9** holes @ **1-1/16**) CV=**109.17** P3/P2=**.322**
Inlet velocity: **15986** ft/min Outlet velocity: **26154** ft/min P2/P1=**.583**
Delivery Line is: **6"**, SCH **40** pipe @ **19023** ft/min
Estimated Noise: **83.2** dBA Safety Valve Relief pressure: **15.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **12501** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
2:14:16 PM

Required STEAM flow 11400 lbs/hr
Inlet pressure 90 psig
Reduced pressure 5 psig
Relief Valve Set Pressure 15 psig
Degrees Superheat 0.0 °F
Steam Temperature 331.0 °F
Standard Valves Y

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Project:
Location: **Weber Hall**
Tag: **1st stage- 1/3**

Engineered w/Noise Supression

Selected Valve: **E** , Size: **1"**, Seat Factor: **FULL**, **STANDARD VALVE**
Required CV=**7.84**, Actual CV=**8.80**, @ **89%** capacity P2=**107.7** (psig)

1 1/4" Orifice Plate (**1** holes @ **1-1/8**) CV=**13.60** P3/P2=**.855**
Inlet velocity: **13843** ft/min Outlet velocity: **18502** ft/min P2/P1=**.743**
Delivery Line is: **1 1/4"**, SCH **40** pipe @ **12565** ft/min
Estimated Noise: **71.9** dBA Safety Valve Relief pressure: **108.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **1704** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
3:44:24 PM

Required STEAM flow 1813 lbs/hr
Inlet pressure 150 psig
Reduced pressure 90 psig
Relief Valve Set Pressure 108.0 psig
Degrees Superheat 0.0 °F
Steam Temperature 366.0 °F
Standard Valves Y

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WATTS INDUSTRIES, INC.

SPENCE ENGINEERING COMPANY, INC.

150 COLDENHAM ROAD, WALDEN, NY 12586-2035 I (914) 778-5566 I FAX: (914) 778-1072

Project:
Location: **weber hall**
Tag: **1st stage 2/3**

User Defined

Selected Valve: **E** , Size: **1 1/2"**, Seat Factor: **FULL**, **STANDARD VALVE**
Required CV=**17.17**, Actual CV=**19.80**, @ **86%** capacity P2=**118.3** (psig)

2" Orifice Plate (**1** holes @ **1-3/8**) CV=**20.31** P3/P2=**.787**
Inlet velocity: **11345** ft/min Outlet velocity: **14010** ft/min P2/P1=**.808**
Delivery Line is: **2"**, SCH **40** pipe @ **10812** ft/min
Estimated Noise: **73.9** dBA Safety Valve Relief pressure: **105.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **3367** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
3:45:55 PM

Required STEAM flow 3500 lbs/hr
Inlet pressure 150 psig
Reduced pressure 90 psig
Relief Valve Set Pressure 105 psig
Degrees Superheat 0.0 °F
Steam Temperature 366.0 °F
Standard Valves Y

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Project:
Location: **Weber hall**
Tag: **2nd stage 1/3**

User Defined

Selected Valve: **E** , Size: **1 1/4"**, Seat Factor: **FULL**, **STANDARD VALVE**
Required CV=**10.34**, Actual CV=**14.10**, @ **73%** capacity P2=**48.5** (psig)

3" Orifice Plate (**4** holes @ **5/8**) CV=**16.79** P3/P2=**.312**
Inlet velocity: **12565** ft/min Outlet velocity: **19872** ft/min P2/P1=**.603**
Delivery Line is: **3"**, SCH **40** pipe @ **11823** ft/min
Estimated Noise: **70.8** dBA Safety Valve Relief pressure: **15.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **2157** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
3:47:47 PM

Required STEAM flow 1813 lbs/hr
Inlet pressure 90 psig
Reduced pressure 5 psig
Relief Valve Set Pressure 15 psig
Degrees Superheat 0.0 °F
Steam Temperature 331.0 °F
Standard Valves Y

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SPENCE ENGINEERING COMPANY, INC.
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Project:
Location: **Weber Hall**
Tag: **2nd stage 2/3**

User Defined

Selected Valve: **E** , Size: **2"**, Seat Factor: **FULL**, **STANDARD VALVE**
Required CV=**20.70**, Actual CV=**31.00**, @ **66%** capacity P2=**52.2** (psig)

4" Orifice Plate (**9** holes @ **9/16**) CV=**30.60** P3/P2=**.294**
Inlet velocity: **10812** ft/min Outlet velocity: **16204** ft/min P2/P1=**.639**
Delivery Line is: **4"**, SCH **40** pipe @ **13254** ft/min
Estimated Noise: **74.4** dBA Safety Valve Relief pressure: **15.0** (psig)
Safety Relief Valve (steam regulator and orifice plate) **4269** lbs/hr MINIMUM

Raw Input . . . .

Steam Regulator
January 15, 2013
3:48:17 PM

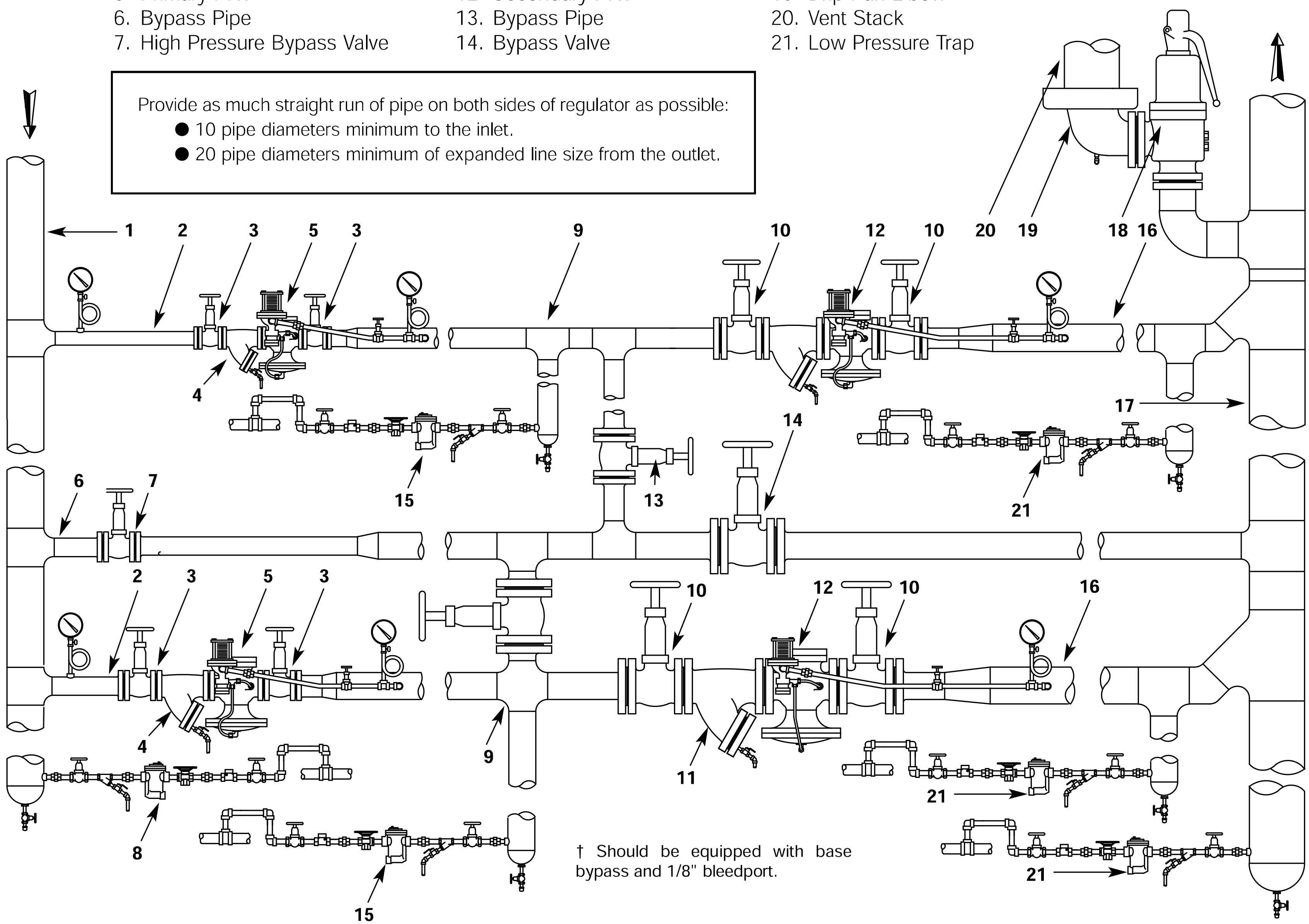
Required STEAM flow 3500 lbs/hr
Inlet pressure 90 psig
Reduced pressure 5 psig
Relief Valve Set Pressure 15 psig
Degrees Superheat 0.0 °F
Steam Temperature 331.0 °F
Standard Valves Y

Spence Engineering accepts no responsibility for the sizing solutions that are provided by this program, as actual operations conditions often vary. It is the user’s responsibility to verify all application information. The sizing solutions that are provided by this program do not take into account the valve materials selection. Selection of valve material is dictated by the service conditions of temperature and pressure.

SPENCE TWO STAGE PARALLEL PRESSURE REDUCING STATION

1. Supply Pipe
2. Inlet Pipe
3. Isolation Valve
4. Strainer
5. Primary PRV†
6. Bypass Pipe
7. High Pressure Bypass Valve
8. High Pressure Trap
9. Intermediate Pipe
10. Isolation Valve
11. Strainer
12. Secondary PRV
13. Bypass Pipe
14. Bypass Valve
15. Medium Pressure Trap
16. Delivery Pipe
17. Discharge Pipe
18. SRV Type
19. Drip Pan Elbow
20. Vent Stack
21. Low Pressure Trap

Provide as much straight run of pipe on both sides of regulator as possible:
- 10 pipe diameters minimum to the inlet.
- 20 pipe diameters minimum of expanded line size from the outlet.



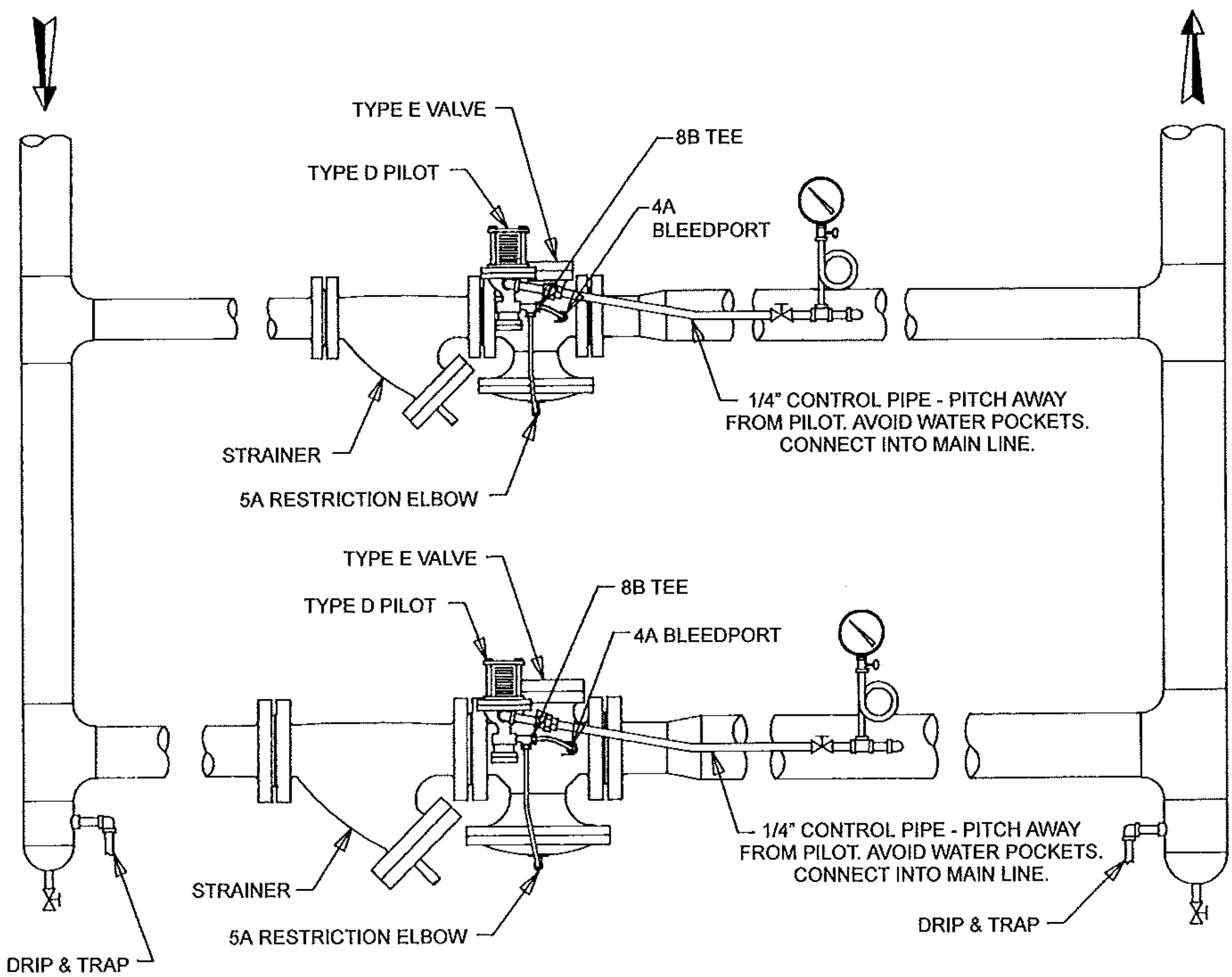
† Should be equipped with base bypass and 1/8" bleedport.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York 12586-2035

INSTALLATION, OPERATING AND MAINTENANCE INSTRUCTIONS START-UP FOR PARALLEL ADDITIVE SYSTEM WITH ED REGULATORS

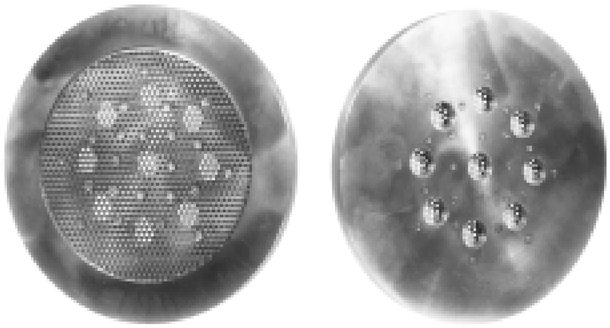
Refer to SIOI 8C

Refer to SIOI 8C, page 2, paragraph F. Large valve is set to desired delivery pressure less 2 or 3 psig. Delivery pressure is set by compressing D pilot spring until desired pressure is reached.
The small valve is set to desired delivery pressure. When maximum flow through small valve is reached, pressure drops slightly and large valve starts to open.



1/4" PIPING, HAND VALVES & GAUGES NOT BY SECO.

PRINTED IN USA



INLET OUTLET
MUFFLING ORIFICE

MUFFLING ORIFICE PLATES (MOPS)

- **Reduces noise by 6 dBA to 12 dBA**
- **Engineered for each application**
- **Designed to fit between ANSI flanges (DIN upon request)**
- **For noise reduction estimates, consult your Representative.**

Canadian Registration # OH 6265.51a

Materials of Construction

Plate ....Steel ASTM A285-78 Gr. C.
Disc ....St. St. 302-2B

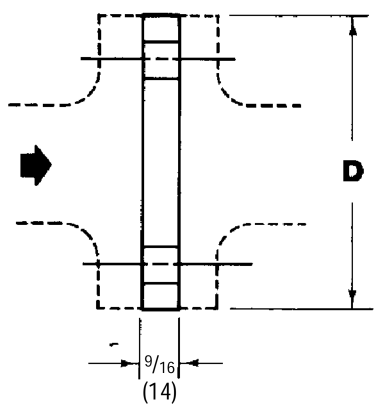
Application Data

- Spence Pressure Regulators or Control Valves where noise reduction is desired

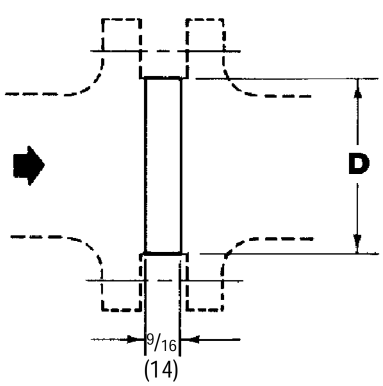
SIZING INFO
PAGE 285

Specification

A Muffling Orifice Plate to be constructed of materials suitable for the installation and compatible with the piping. Generally, it is to be of steel construction with stainless steel plate weldedto the primary plate. The orifices are to be on the stainless steel plate. Orifice plates are to be designed for installation between two ANSI flanges in the enlarged piping downstream of the regulator or noise suppressor. Muffling Orifice Plates are to be designed to provide between 6 to 12 dBA of noise reduction on a high flow PRV.



ANSI 125 & 150 FLANGED



ANSI 250, 300 & 600 FLANGED

DIMENSIONS inches (mm)

NOMINAL PIPE SIZE	DIMENSION D ANSI 125 150	ANSI 250 300	ANSI 600
2 (50)	6 (152)	4 3/16 (106)	3 5/8 (92)
2 1/2 (65)	7 (178)	4 15/16 (126)	4 1/8 (105)
3 (75)	7 1/2 (190)	5 11/16 (146)	5 (127)
4 (100)	9 (229)	6 15/16 (178)	6 3/16 (156)
5 (125)	10 (254)	8 5/16 (210)	7 5/16 (184)
6 (150)	11 (279)	9 11/16 (247)	8 1/2 (216)
8 (200)	13 1/2 (343)	11 15/16 (305)	10 5/8 (270)
10 (250)	16 (406)	14 1/16 (357)	12 3/4 (324)
12 (300)	19 (483)	16 7/16 (419)	15 (381)
14 (350)	21 (533)	18 15/16 (481)	16 1/4 (413)
16 (400)	23 1/2 (597)	21 1/16 (534)	18 1/2 (470)
18 (450)	25 (635)	23 5/16 (591)	21 (533)

RECOMMENDED INSTALLATION OF PRESSURE REGULATOR WITH MUFFLING ORIFICE