Hydronic Service Valve Product Development

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Since the inception of modern mechanical and HVAC systems, maintenance and repairs have been prevalent in both contracting and facility operations. The average life of HVAC equipment is fractional compared to the life of buildings as construction technologies improve. Traditionally, the serviceability of heating and cooling equipment has entailed the significant amounts of labor and materials to disruptively drain or freeze hydronic systems in order to cut in means of bypassing the main system, swapping out equipment, or repair. The intent of this project is to explore alternative methods to forgo the aforementioned negative impacts of service and to improve the way systems are maintained. Ultimately, the construction industry and facilities need to invoke mechanical contractors to ask: Is there a better way? What else can improve? The intent of this research is to improve the way systems are maintained. The solution is a valve that can aid in performing service functions without the intensive use of labor and disruption to the facility. The solution is to prevent having to majorly alter a system and its performance through simultaneous isolation, drain, and bypass capabilities. The result is an affordable alternative with an overall greater functionality.

Key Words: MEP Construction, Mechanical, Hydronic Piping, Valve, Maintenance

Introduction

In most commercial building, a heating, ventilation, and air conditioning (HVAC) system consists of three components. First, the air moving equipment that generates and distributes air to various areas of the building. Second, the hydronic piping system that transfers heat to the air. And third, the electrical or pneumatic controls system that manipulates air distribution and temperature. These three components are often described as the dry, wet, and logic side of mechanical contracting. Together, dry, wet, and logic components provide "simultaneous control of all or at least three of those factors affecting both the physical and chemical conditions of the atmosphere within any structure. These factors include the following: temperature, humidity, air movement, air distribution, dust, bacteria, odors, and toxic gases" (Brumbaugh, 1977). These eight factors, described by industry pioneer Jim Brumbaugh in 1977, still hold true today. These factors are often described as goals in mechanical contracting in various forms of codes and contract documentation.

However, the continued advancement in mechanical equipment and material is disproportionately less than the advancement in building technologies. The result is the need to service or change out equipment within the lifespan of an operational building. Also, the type of occupancy or use of the building can change in a building’s lifespan, requiring alterations to be made to the HVAC system as well. Typically, the dry and logic side of an HVAC system are most quickly in need of major repair, outdated, or no longer applicable to the overall building function. Therefore, the existing hydronic piping is demolished, abandoned in place, used for temporary equipment, or integrated into the new system. For the two later options, the extensive use of material and labor can make for expensive operations, creating an inefficiency, and an opportunity to improve. While Brumbaugh’s eight factors are still relevant today, they are perhaps incomplete for not including longevity.

Of the countless hydronic and plumbing fittings, none are designed to specifically to address the cradle to grave longevity and maintenance of HVAC systems. During the early development of
modern HVAC systems until now, products are developed to directly address a problem. Perhaps most notably, ASHRAE Fellow and Bell and Gossett Engineer, Gilbert Carlson developed several hydronic piping revolutionary products. In an interview, Carlson was described as “a genius. He not only invented heating products, but he developed new ways to design systems, which often began with a problem and led to breakthrough thinking in the science of hydronic heating” (Konopacz, 2016). While Carlson made his advancements through engineering, this project instead delves into the construction of these systems. It is the intent of this project to develop a hydronic fitting that avoids the aforementioned inefficient use of labor and material during major service operations.

**Project Origins**

The initial idea for this project came from an active hospital project where four air handling units (AHU) were being removed and replaced with three new ones. Being a hospital project in California, the mechanical contractor had to comply with the Office of Statewide Health Planning and Development (OSHPD). Part of the OSHPD requirements were to maintain existing pressure relationships between rooms while providing a “satisfactory” amount of cooling. To obtain this requirement, the contractor opted to utilize a temporary AHU fully integrated with the existing ductwork and hydronic system. The resulting hydronic workflow consisted of the following:

- Provide chilled and hot heating water to and from the temporary AHU
- Bypass the main hydronic lines, diverting to the temporary AHU
- Drain the existing hydronic lines
- Remove hydronic connections from existing AHU’s
- Make connections at new AHU’s
- Bypass the temporary system, diverting existing hydronic mains to the new AHU’s
- Decommission the temporary AHU
- Cut in a bypass of the new system to service reheat coils while operating the new AHU’s
- Restore normal flow and commission the new system
- Remove the temporary system

The back and forth movement from existing to temporary to new HVAC system consisted of many man-hours and additional material that seemed the only logical way to achieve the intended outcome. Upon project completion, during an internal contractor meeting, alternative procedures were thought of. It was decided in the meeting that this method was the only thing that could have been implemented given the constraints of an active hospital, OSHPD requirements, and other site conditions. It was only until sometime later, the idea came that maybe there was another way to service systems.

**Process**

With a clear problem to solve and an initial idea in mind, the research began to see what types of valves already existed that would function in a way needed to eliminate the back and forth service of major equipment swap outs. From this research, it was evident that other valves and assemblies could be used to function in the envisioned way. Double-block-and-bleed valves or manifolds already exist, but their material type, size, and assembly make them exclusive to process oil piping. Also, there are diverting valves that can divert hydronic flow in two directions. However, diverting valves can only have two ports open at once, which is not ideal for a fast drain down. So, after looking through the different valves, such as the double-block-and-bleed and diverting valves, it was decided that the basis for further exploration and design was justified.

The time spent looking at the defects in existing valves for service functionality was not wasted. Through finding what other product were lacking, it could then be determined what desirable features
were to be included into the design of the hydronic service valve. Ultimately, the additional criteria desired in this valve was narrowed down to the following:

- Pressure and temperature ports (P/T ports)
- Ability to isolate sections of a hydronic system
- Three open ports at a time
- The option of a male hose thread service connection

From there, it was decided that the design should contain simple geometry to keep the cost of manufacturing low. Ultimately, the drive for design was to create a brass valve with female threaded connection to avoid using dielectric unions, required between ferrous and nonferrous metals. Also, the cost had to be less than the five existing fittings that could make up an assembly to perform the same function as the hydronic service valve. After hand sketching, the final model was made using a Revit Family, and the final two dimensional cross sections were made using AutoCAD. For other elements of design, such as ASTM and ANSI standards, the information from existing valve product data was applicable to the new valve being developed. Based off of the design and intended function of the hydronic service valve, it was dubbed as an Isolation Service Valve (ISV).

With the ISV design established, the pricing had to be developed. As previously mentioned, the pricing is the crux of the design to both address the issue of labor and material. To estimate the existing cost of cutting in a bypass assembly, Sweet's Unit Cost Guide 2002 was used for material and labor unit quantities. Items not listed in the Sweet's Unit Cost Guide 2002 were established based off of local vendor list pricing and a local mechanical contractor’s labor data. The wage was set using the California Department of Industrial Relations data in San Luis Obispo County, and rounded up to the nearest whole five dollars to account for other incidentals such as per diem, and gas reimbursements. An additional two hours were allocated to the overall labor cost to account for the time to prepare and execute the draining of a hydronic system. Labor factors were also implemented to account for the pipe fitter’s familiarity with existing fittings and valves. Estimating the ISV was done based off a rough calculation of cost per weight, which equated to be a little under an additional twenty percent (20%) of a traditional ball valve. So, that factor of twenty percent (20%) was added to all ball valve data, with the exception of the labor factor. The ISV labor factor was reduced to account for a pipe fitters familiarity with female threaded fittings, but was reduced significantly less than the traditional fittings. The result is an estimated savings of seventy-three percent (73%).

Lastly, a warranty was developed, using mostly boilerplate legal conditions, but also including ISV specific information. The information added to the standard warranty language are the process of arbitration, and the type of liquids and gases that the ISV is designed for.

**Deliverables**

Organizing the design, function, and price of the ISV was determined to be most efficiently done in a product brochure delivery. Some of the general structure of the ISV product brochure was adopted from Honeywell’s diverting valve. The contents include: specifications; an install, operation and maintenance manual (IO&M); parts catalog; list pricing; and warranty (see Appendix A).

**Lessons Learned**

The idea was informally introduced before the initial design phase to the company from the aforementioned hospital project and specifically to the CEO, Chris McCall. At first, McCall received the product well. After completion of the product development, the completed ISV product data was shown to the mechanical contractor team. After speaking with the team, a valid point was made: it is more often that the original contractor did not install the hydronic system in a workmanlike manner.
that causes major service projects years later. Therefore, it is not likely that an installer of a low
caliber would have the foresight to install a product like the ISV. Yet, this does not eliminate all use
for the ISV. Instead, the use is more limited to either high caliber mechanical contractors, or in cut in
operations. Cutting in the ISV will reduce the savings of seventy-three percent (73%), but is still a
viable, cost effective option.

Furthermore, the product has been designed from the perspective of a pipe fitter, and not from a
mechanical engineer. However, to develop the ISV, mechanical engineering principles and to be
learned. The result is a product with perceived great functionality, but further testing of a prototype
would be needed to determine pressure drops, and other possible miscellaneous detriments that could
further limit the use of the ISV. Ultimately, the product development was an exercise in multiple
construction related activities such as detailing, estimating, metallurgy, contract (warranty) writing,
and creating work breakdown structures.

References

Brumbaugh, James E. (1976) HEATING, VENTILATION and AIR CONDITIONING LIBRARY:
Indianapolis, Indiana

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Konopacz, Larry (2016) Bell & Gossett Celebrates 100 Years of Innovation Part 1 of 2 [WWW
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part-1-of-2.

Appendix A

Please see the following pages for IVS product brochure.
Model Numbers ISV-43-75 through ISV-43-300
4-Positioned 3-Port Diversion

Features:

• Service and Maintenance Model

• Bronze body with female threaded connections at main ports

• Optional male and female hose thread connections available for 3/4” port sizes

• Stainless steel stem and replaceable packing

• Water, low pressure steam, and glycol (under 50% solution) compatible

• Replaceable parts available

Applications:

The ISV-43 Model is designed for hydronic piping systems carrying water, low pressure steam, or glycol solutions (under 50% solution). These valves are used for a variety of service and maintenance operations, including:

• Bypass of Mains or Equipment
• Draining
• Pressure & Temperature Testing
• Chemical Feed
• Chlorine Flushing
• Isolation

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## Specifications

### Profile

(IVS-43-200 shown)

### Isometric

(IVS-43-200 shown)

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**Sizing & Options**
Specifications

Models
IVS-43-75 through IVS-43-300

Dimensions
See Pg.2 Sizes & Options

Flow Characteristics
Linear equal percentage flow

Temperature and Pressure Ratings
Maximum Pressure: 150 PSI
Maximum Temperature: 230 °F

Maximum Pressure Differential
3 Ports Open: 150 PSI
2 Main Ports Open: 130 PSI
1 Main & Tee Port Open: 125 PSI

Materials
Body: Bronze ASTM B62
Stem: Stainless Still ASTM A351
Packing: Teflon/rubber ANSI150
Disc and Plug: Linear contour plug, one piece brass construction for metal-to-metal seating
Seat: IVS-43-250, 300: BRZ, removable cage
IVS-75 through 200: Integral brass

Accessories
See Parts Catalog pg. 7
Installation, Operation & Maintenance

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to do so could result in damage to the product or system.

2. Make sure this product is applicable to plumbing/piping system and being used as intended.

3. After installation, follow operational procedures.

Location & Clearances

1. When possible, put the valve on the low point of system for draining operations.

2. Leave at least 6" from the bottom of valve to ground to easily access service connection.

3. Use handle extensions if the valve is to be insulated. See Parts Catalog pg.7.

4. Provide at minimum 3 pipe diameters length between this valve and other components.

Piping Connections

All piping must comply with all applicable codes and ordinances. Refer to figure below for typical connections.

Valve Implementation at AHU Connection

Use Similarly for ANY Mechanical Equipment Connections instead of SOV's.
Installation, Operation & Maintenance

Valve Installation

Threaded Body Connection: Line up the pipes squarely with the valve at each end. If the pipes are forced into the valve, the body may become twisted and improper seating will result. Prevent pipe chips, scale, and dirt from entering the piping since they may lodge in the seat and prevent closing. Apply a vise or wrench to the valve and make the threaded connection. Leave a maximum of two (2) bare threads exposed.

Hose Port Connection: Line up the hose connection to the valve. Manually thread the hose adapter onto the valve until finger-tight. Turn the hose adapter, not the valve, an additional half turn tighter with channel locks only if valve threads are still uncovered.

P/T Port Connection: Remove cap from P/T ports. Insert testing device with stem that is no longer than half of the valve nominal diameter.

Implement the ISV-43 into your BIM Model...
Installation, Operation & Maintenance

OPERATION

Refer to below figures and tables for ISV operation capabilities

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<th>Valve Position</th>
<th>Typical Operation (not limited to the following)</th>
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Operation of Valve Positioning
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Refer to most recent pricing on all Valves and Parts

See How You Can Save up to 73% on Material and Labor...

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<td>3/4&quot; FIP x MHT BV</td>
<td>1</td>
<td>EA</td>
<td>$10.79</td>
<td>0.730</td>
<td>95%</td>
<td>$65.00</td>
<td>0.684</td>
<td>$44.46</td>
<td>$10.79</td>
<td>$55.35</td>
</tr>
<tr>
<td>3/4&quot; FTG x MIP</td>
<td>1</td>
<td>EA</td>
<td>$14.45</td>
<td>0.122</td>
<td>80%</td>
<td>$65.00</td>
<td>0.098</td>
<td>$6.34</td>
<td>$14.45</td>
<td>$20.79</td>
</tr>
<tr>
<td>Drain Down or Freeze</td>
<td>1</td>
<td>LS</td>
<td>--</td>
<td>2.000</td>
<td>100%</td>
<td>$65.00</td>
<td>2.000</td>
<td>$130.00</td>
<td>--</td>
<td>$130.00</td>
</tr>
<tr>
<td>TRADITIONAL SERVICE ISOLATION METHOD (USING MULTIPLE FITTINGS) - TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$392.18</td>
<td>$155.31</td>
<td>$547.49</td>
</tr>
</tbody>
</table>

When using the ISV-43 versus traditional methods of servicing systems, you get:

**SAVINGS OF:** $399.23  73%  4.4 MH’s  73%

Notes:

1) Unit Costs are average from multiple vendor list pricing
2) Man Hours are derived from: Sweet’s Unit Cost Guide 2002
3) Labor Factors are intended to reflect labor experience with different fittings and valves, and is subject to change
4) IVS Man Hours assumed to be 20% higher than traditional isolation valves
5) IVS Labor Factor set to 95% based off of similarity in connection style, material, and design
## Warranty

**AGREEMENT THROUGH PURCHASE**

**IMPORTANT:** SECTION E contains a binding Arbitration Agreement and Class Action Waiver. It affects how disputes are resolved. Please read it.

### SECTION A - Limited Warranty

Isolation Service Valve (ISV) shall be free from defect and assembled in a workmanlike manner. Performances described in "IO&M Manual" shall perform for at least one (1) year, starting from the date of shipment. During the Warranty Period, if the ISV is not functioning properly due to a defect in material or manufacturer workmanship, then ISV Manufacturer will either:

1. repair the hardware,
2. replace the hardware with equal to original product, or
3. refund the purchase.

Other remedy options will not be considered. The aforementioned remedies will be chosen at ISV Manufacturer’s discretion.

You may have the right to return the ISV for a refund within ninety (90) days of shipment. All refunded ISV’s and parts listed in "Parts Catalog" are property of the ISV Manufacturer upon delivery.

### SECTION B - Exclusions

This Warranty does not apply if the ISV,

1. has been modified or repaired by any entity other than ISV Manufacturer designated repairers,
2. has been abused, misused, improperly maintained or neglected,
3. has been damaged by exposure to a natural disaster or other Force Majeure incidents,
4. has been used in any way outside of description in "IO&M Manual"
5. has been exposed for anything other than water, LPS, or glycol solution above fifty percent (50%),
6. has been cleaned with substances other than water, LPS, or gas solution above 250 ppm,
7. is further damaged beyond Warranty conditions during the return of product, or
8. is used for industrial/process applications,

### SECTION C - Limitations

Implied Warranties, including an Implied Warranty of Merchantability or Fitness for a particular purpose, have the same duration as the this Warranty. If your jurisdiction does not allow constriction on Implied Warranty periods or has statutes stating otherwise, then the Implied Warranty period stated herein will not apply to you.

ISV Manufacturer is not responsible for consequential damages; loss of privacy, data, confidentiality, or profits. ISV Manufacturer is not responsible for inability to properly utilize this product. ISV Manufacturer will assume no liability beyond the purchased price if remedy goes beyond the extent of repair to hardware, replacement of hardware, or refund of purchased price when applicable.

This Warranty gives you specific legal rights, in addition to your local jurisdiction.

### SECTION D - Governing Law

You and IVS Manufacturing agree that this Warranty has been created and executed in the State of California, U.S.A. and within the bounds of California Law, excluding the bounds of conflicting law principles.

### SECTION E - Agreement: Dispute Resolution - (following page)
SECTION E - Agreement: Dispute Resolution

This section and action described herein will be applied to the maximum extent permissible by law. For product consumers outside of the U.S.A. this section does not apply to you. The following is how product consumers and ISV Manufacturer have agreed to resolve all disputes:

1. Must Arbitrate all Claims Except Unauthorized Use, Privacy, or Theft.

You and ISV Manufacturer have agreed to resolve all disputes and claims between us in binding arbitration. That includes, but is not limited to, any claims arising out of or relating to:
   a. Any aspect of the relationship between us,
   b. This Warranty, or
   c. The valve itself, accessories, or items found on "Parts Catalog" including:
      i. Price
      ii. Purchase transaction
      iii. Expectations from other than ISV Manufacturing

This applies regardless of the type of law infraction you are claiming (i.e. contract, tort, fraud, et al), and what type of law theory is being implemented.

However, SECTION E.1 does not prevent you or ISV Manufacturer to bring the following to court:
   a. Claims of infringement, or other misuse of other intellectual property rights
   b. Claims of injunctive relief
   c. Claims related to alleged unauthorized use, privacy or theft

This Warranty, and specifically SECTION E, does not prevent you from bringing your dispute to the attention of a local, state, or federal agency that can provide relief, within the bounds of said agency laws.

An arbitration is a dispute resolution proceeding before a neutral arbitrator. Arbitration provides limited discovery, and informality compared to traditional means of resolution. The findings of an arbitration are subject to very limited review by judicial courts. The arbitrator will issue a written decision and provide a statement of reasons if requested by either you or ISV Manufacturer. WITH PURCHASE OF AN ISV MANUFACTURER PRODUCT, YOU UNDERSTAND THAT YOU AND ISV MANUFACTURER ARE GIVING UP THE RIGHT TO SUE IN COURT AND TO HAVE A TRIAL BEFORE A JUDGE OR JURY; A CLASS OR REPRESENTATIVE ACTION LAWSUIT; OR ANY CIVIL ACTION.

2. Try to Resolve Dispute Informally First.

You and ISV Manufacturer agree to make reasonable, good faith efforts to informally resolve any dispute before initiating arbitration. A party who intends to seek arbitration must first send the other a written notice that describes the nature and basis of the claim or dispute and sets forth the relief sought. If you and ISV Manufacturer do not reach an agreement to resolve that claim or dispute within 30 days after the notice is received, you or ISV Manufacturer may commence an arbitration.

3. Arbitration Rules and Fees

All Rules and Fees will adhere to the American Arbitration Association guidelines. Furthermore, the neutral arbitrator will be selected from the National Construction Dispute Resolution Committee (NCDRC).

4. Illegalities in Parts of Warranty

If any part of the Warranty is found to be illegal, then that selective part will be void. However, the rest of the Warranty information will remain relevant.