Autodesk University 2012

Achieving Environmental and Safety Excellence at Operating Plants by Using AutoCAD® P&ID

Jess Askey – Environmental intellect
Shale Robison – AllCAD Northwest
Aditya Kumaran – Environmental intellect

PD3025

In this class, we will present the need for a change in how compliance issues are tackled in various industries regulated by the Occupational Safety Health Administration (OSHA) and Environmental Protection Agency (EPA). The limitations and inefficiencies of industry-standard work practices and data systems will be examined for cost and non-compliance implications. We will do case studies and demonstrations for how petroleum refineries have implemented AutoCAD® P&ID software as part of environmental and safety compliance projects to achieve a reduction in actual and reported VOC and HAP emissions. We will cover a stepwise workflow process for owner-operators and engineering, procurement, and construction firms to follow, engaging various plant disciplines, including CAD, engineering, and environmental and safety that are favorably affected by this workflow. Specifically, the case study will share a process for using data-driven drawings to achieve improved compliance with environmental and safety regulations.

Learning Objectives

At the end of this class, you will be able to:

- Attain an awareness of the petroleum refining industry with respect to compliance standards, through specific regards to emerging issues with the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA).
- Acquire knowledge of what the new generation of Smart, Data-Driven P&IDs are, as opposed to the older drawing functions.
- Obtain a step flow understanding of how drawings with no underlying data and features can be converted into Smart P&IDs with new functionalities.
- Achieve an understanding of what the Ei Intelligence software's capabilities are and how it works in conjunction with AutoCAD P&ID, using a case study with LyondellBasell.

About the Speaker

Mr. Jess Askey has over twenty years of experience in software development and strives to create innovative and robust solutions for a diverse array of industries. Jess has worked on a litany of projects during his career ranging from embedded systems design to wide-area enterprise software solutions. His personal interests started him in assembly language for arcade gaming systems which subsequently grew into a C++ based architecture system for creating and designing game and game platforms.

Expanding into the information technology real, Jess involved himself at several Wyoming-based software development and service companies involved in the structured materials, plastics cataloging and environmental engineering industries. Jess currently serves as the software architect for Environmental intellect, and has been an integral leader in the industry to work with a more data-driven AutoCAD platform, which he is designing software for now.

Email: jess@env-int.com

Mr. Aditya Kumaran is a graduate from the Industrial and Enterprise Systems Engineering Department at the University of Illinois at Urbana-Champaign. His background is technical, with an emphasis on problem-solving and design of engineering solutions. He was a Business Intelligence intern at Orbitz Worldwide where he was responsible for creating and managing a Data Dictionary that was to house performance metrics that Orbitz used on a daily basis. He used his product to conduct analytical tests with data which supported key product developmental decisions. In university, he participated in an on-site feasibility analysis of geothermal energy for Danville Metal Stamping Company, where his team performed on-site consulting. His team's work was recognized and published by the department, and entered into the national Lincoln Arc Welding Competition. Aditya started helping out at Environmental intellect in his senior year, and has recently joined full-time. He has so far played an important role in company projects and has worked through the conversion of existing AutoCAD® drawings into Intelligent format. He has also edited, printed and plotted drawings in the AutoCAD® P&ID workspace and is gaining experience using AutoCAD® P&ID.

Email: aditya@env-int.com

Mr. Shale Robison has 19 years of multi-discipline, multi-platform CAD experience performing conversion, drafting, design, modeling, mapping, data management, compliance, and training services for owner operators and consulting engineers on projects across the globe. He studied mechanical engineering for three and a half years at Brigham Young University and Boise State University before establishing All CAD Northwest, a premier engineering support service company with offices in Meridian, ID and Richland, WA where he serves as President. The areas of emphasis for the company are structural, both commercial and industrial, and process facilities, including food & beverage, petro-chem, water/wastewater, nuclear, and mining. We leverage the latest technology to help plant facilities increase efficiency and maintain safety. Under his leadership the staff at All CAD has been involved in the mainstreaming of Autodesk plant solutions from the beginning.

Email: srobison@allcadnw.com

Environmental and Safety Compliance in Petroleum Refining Industries

Introduction

The petroleum refining industry is undoubtedly the most heavily regulated manufacturing industry in the United States. For companies in the oil and gas industry, the risks and costs associated with being non-compliant are increasing and some refiners can operate at losses of millions of dollars on a daily basis. In particular, Environmental, Health and Safety (EH&S) laws are becoming increasingly more stringent, leading to increased capital and operating expenditures in order to demonstrate and maintain compliance. One such example is the cost of Cap and Trade under the Federal Greenhouse Gases Mandatory Reporting rule, which places a cap on emissions which if not followed will lead to financial penalties. In just one element of EH&S compliance, air quality, there are capital and operating costs associated with labor for permitting, program management, routine inspections, equipment repairs, compliance audits as well as daily, weekly, quarterly and semi-annual recordkeeping and reporting requirements.

Governing Bodies

Petroleum refiners in the United States deal with specific regulatory requirements issued by governing bodies – particularly the Environmental Protection Agency (EPA) and the Occupational Health and Safety Administration (OSHA). The EPA and OSHA's missions can be summarized as follows:

- Taking Action on Climate Change and Improving Air Quality
- Protecting America's Waters
- Cleaning Up Communities and Advancing Sustainable Development
- Ensuring the Safety of Chemicals and Preventing Pollution
- Providing training, outreach, education and assistance
- Enforcing Environmental Laws

The "hot topic" in the environmental compliance industry now is the EPA's Information Collection Request (ICR). In early April of 2011, the EPA sent the ICR questionnaire to all 152 petroleum refineries in the US. As part of the ICR, each refinery is required to respond to several hundred questions included in the questionnaire, as well as update their air emissions inventories. It is understood that the EPA plans to use the information collected to evaluate current environmental regulations and to potentially propose stricter enforcement laws.

The time requirement for each facility to respond to this ICR has been estimated to be anywhere from a few hundred to several thousand hours, so naturally there are so many opportunities for compliance “hiccups”. Especially when refiners struggle with developing component counts for several areas, the process can be delayed. For example, facilities that don’t use AutoCAD® P&ID in its full capacity will not being able to provide a count for the number of valves in natural gas service or the number of flanges in heavy liquid service. We will discuss this in more detail later.

Areas of compliance and costs associated with non-compliance

There are four main emerging areas of compliance are Greenhouse Gases (GHG), Leak Detection and Repair (LDAR), Benzene Waste Operations NESHAP (BWON), and Process Safety Management (PSM). For our presentation, we will focus on LDAR compliance and Fugitive Emissions. LDAR compliance hinges on communication and program management in the face of perpetual change. The foundation for a successful and compliant LDAR Program is an accurate set of P&IDs and a functional, regulatory-driven LDAR database. LDAR compliance is a prime example of our discussion for the need for data-driven drawings in AutoCAD®.

With respect to Fugitive Emissions, there are still a number of refineries that are not in compliance with LDAR requirements because of the numerous requirements related to equipment identification, monitoring, repair, recordkeeping and reporting. The average refinery has at least three LDAR regulations to abide by:

1) A State or local rule,
2) At least one Federal LDAR rule,
3) A US EPA Consent Decree (which is essentially an agreement between EPA and a refining corporation to abide by a stricter set of LDAR requirements).

After being to close to one hundred LDAR audits, I’ve come to the conclusion that such a thing as “100% LDAR Compliance” cannot be achieved; however, there is a lot of room for improvement.

The costs and penalties associated with non-compliance vary and often, are difficult to catalog. I’ve seen facilities be fined as much as tens of millions of dollars and then seen smaller facilities get fined as little as a couple of thousand dollars for LDAR violations. The Office of Enforcement Compliance Assistance (OECA), which works in conjunction with the EPA to enforce environmental laws, claims that 28 Consent Decree (CD) settlements covering 90% of the U.S. refining capacity have been negotiated since early 2000. As part of these settlements, over $6

B has been surrendered to either pay for enhanced control technologies, civil penalties, and supplemental environmental projects. LDAR is just one part of the CDs, but certainly, the stipulated penalties associated with LDAR non-compliance increases the stakes. For example, some Consent Decrees provide a penalty of $100 per day for a single valve that is not included in the LDAR program that should be. If a facility, which has 50,000 valves, missed 10 valves from its inventory in one process (and note that is 99.98% accurate), then this would equate to a stipulated penalty of over $240,000 for a two-year period. That's a steep price to pay, and for only 10 valves missing from the inventory! But the EPA, in combination with OECA, is continuing to invest its own resources to ensure compliance with LDAR requirements.

Current compliance processes

Compliance with LDAR regulations historically has been accomplished through a system of manual processes that, among other things, requires an in-depth understanding of the regulations, as well as knowledge of operational and engineering processes in order to define LDAR applicability. Manpower resources, which are oftentimes provided by contractors, are needed in order to manage LDAR equipment inventories and inspections. Usually, various data systems, such as LDAR databases, spreadsheets, and compliance tasking software are used in order to generate required records and reports. And probably the most difficult aspect of maintaining LDAR compliance surrounds the Management of Change, or MOC, process. In an operating plant environment, change is constantly occurring; and these changes can and do impact compliance. Therefore, an effective MOC process is essential to complying with LDAR rules. Now, these traditional techniques lack the sophistication to be able to easily and efficiently determine regulatory applicability at a particular plant process. Over a long period of time, it becomes extremely difficult to track compliance with LDAR, especially if the plant or project is large, complex, and/or constantly changing.-

Using AutoCAD® P&ID to generate Intelligent, Data-Driven Drawings

The following are top 10 reasons to move from AutoCAD® to AutoCAD® P&ID, taken from an article posted on May 18th, 2010 on http:/www.technology4design.com:

Made specifically for P&ID process plant designers and engineers, AutoCAD® P&ID software enables faster and more efficient creation, manipulation, and revisions to P&ID drawings.

1. **Industry-standard P&ID symbols**

   AutoCAD® P&ID includes complete P&ID symbol libraries conforming to standards for PIP, ISA, JIS, and ISO/DIN. Easy-to-use tool palettes provide quick access to equipment, lines, and components needed to create P&ID drawings.

2. **Easy-to-learn interface**

   AutoCAD® P&ID is built on the most up-to-date version of AutoCAD® software and leverages standard AutoCAD features. The AutoCAD® P&ID interface enhancements allow quick start-up time and increased productivity with little to no training. If you know AutoCAD, learning AutoCAD P&ID is easy and maintenance doesn't require complex IT support.

3. **Dynamic process and signal lines**

   Easy-to-draw process lines automatically snap to equipment connection points and intelligently reroute when connected equipment is moved. Lines automatically break and mend as components are attached or removed. Intuitive edit control grips make editing lines quick and easy.

4. **Dynamic components**

   AutoCAD® P&ID provides industry standard components that can be edited and moved using intuitive control grips. Components automatically align and snap into location when placed on process lines. When a process or signal line is moved or edited, components stick with the line, maintaining the right order, orientation, and relationship to the line.

5. **Easy symbol creation and substitution**

   AutoCAD® P&ID lets you customize and convert a group of geometric shapes or lines into distinct components or equipment to meet your company standards. Add new symbols to the project symbol library to increase drawing consistency within the organization. Substitute an existing drawing symbol with a new, similar symbol with a single click.

6. **Report and list generation**

   The AutoCAD® P&ID Data Manager feature makes it easy to generate, view, and print a variety of common reports for all drawings in a project. Reports include Instrument Lists, Line Lists, Equipment Lists, and Valve Lists. Use AutoCAD® P&ID to create and customize these reports.

7. **Import and export to Microsoft Excel**

   Many engineering teams across disciplines provide input on the information contained in the P&ID drawings. Share drawing data with other teams by exporting the drawing or project data to Microsoft Excel and then importing the updated information back into the drawings. Electronically transmit P&ID drawing files containing embedded information without the need to query and filter data from a database.

8. **Review and approve data edits**

   AutoCAD® P&ID makes it easy to identify all changes submitted when data is imported from Excel. Click on changes in the Data Manager to highlight both the suggested change and to display the relevant part of the drawing. Changes can be accepted or rejected individually or in groups—a feature that helps manage revisions made externally and maintains the integrity of the drawing files.

9. **Tag generation and uniqueness**

   As you add objects to a drawing, AutoCAD® P&ID maintains the uniqueness of the object across all drawings in the project, which helps prevent users from purchasing the same plant asset multiple times. Enter associated data properties for all symbols and drawing elements at any time throughout the project.

10. **Search and edit using a spreadsheet interface**

    The Data Manager functionality—a dedicated utility within AutoCAD® P&ID—applies a spreadsheet interface to all the objects on a drawing. Use the Data Manager to sort, filter, and find components in P&ID drawings and quickly enter data properties specific to those objects. Line numbers, component values, and other data edited in the Data Manager are instantly updated in your P&ID drawings. Zooming features within Data Manager instantly zoom your drawing window to the appropriate drawing object or record in the Data Manager.

This upcoming section provides guidance to CAD professionals to implement AutoCAD® P&ID and/or to convert drawings in existing "dumb" format to "intelligent" format. It is intended to:

- Provide useful definitions for reference purposes.
- Outline general steps for setting up the project database and for converting .dwg file format drawings into AutoCAD P&ID.
- Specify detailed instructions on how to draw piping and equipment to ensure proper connectivity of equipment.
- Reference guidelines for reviewing marked-up process flow diagrams (PFDs) in order to assign accurate LDAR streams to corresponding equipment on piping and instrumentation diagrams (P&IDs); and
- State procedures for including annotations for equipment (i.e., valves, pumps, PRVs, connectors, etc.) subject to LDAR.

Definitions

HAPs – Hazardous Air Pollutants are chemicals which can cause adverse effects to human health or the environment. Congress has identified over 188 of these pollutants, including substances that cause cancer, neurological, respiratory, and reproductive effects. A refinery stream is considered to be a HAP regulated stream if it contains >5% HAP by weight.

Heavy Liquid Service – In heavy liquid service means that the piece of equipment contains a process liquid with a 10% or greater weight percentage of volatile organic compounds by mass with a vapor pressure of one or more pure components equal to or less than that of kerosene (< 0.1 psia at 100 degrees oF or 0.3 kPa at 20 C and that equipment is not in gas/vapor service or in light liquid service).

LDAR – Leak Detection and Repair Program

Light Liquid Service – In light liquid service means that the piece of equipment contains a liquid having 10 wt. % or more of VOC in which the vapor pressure of one or more of the components is greater than 0.3 kPa at 20 KC.

MSDS – Material Safety Data Sheets

P&IDs – Process Instrument Diagrams

PFDs – Process Flow Diagrams

Gas-Vapor Service – In gas-vapor service means that the piece of equipment contains process fluid that is in the gaseous state at operating conditions.

VOCs – Volatile Organic Compound. Volatile organic compounds are emitted as gases from certain solids or liquids and include a variety of chemicals, some of which may have short and long-term adverse health effects. A refinery stream is considered to be a VOC stream if it contains >10% VOC by weight.

Procedures

PFDs and P&IDs are obtained from the project manager in electronic form as .dwg files. There is a separate file for each drawing, which is typically in an extended "scroll-format." A list of all drawings received has been created, which includes file name, drawing revision numbers and revision dates. This file is entitled as the Drawing Tracker.

Overall AutoCAD® P&ID Conversion Process

The process of converting .dwg file drawings into intelligent, or smart, P&IDs involves several steps. A project database must be set-up that includes site-specific information, including an import of the refinery's block library. After the project database is set-up, the .dwg format drawings are imported into CAD workspace and generally converted into smart P&IDs by tracing over the top of the imported drawing. As the CAD professional re-traces the .dwg drawing, he/she will add "intelligence" to all of the objects that are being re-drawn. The following sections provide a general overview of the P&ID conversion process, as well as specific details to adhere to.

AutoCAD® Project Database and P&ID Conversion Setup

The following subsections identify procedures for setting up AutoCAD P&ID, implementing, and adhering to quality assurance / quality control (QA/QC) requirements:

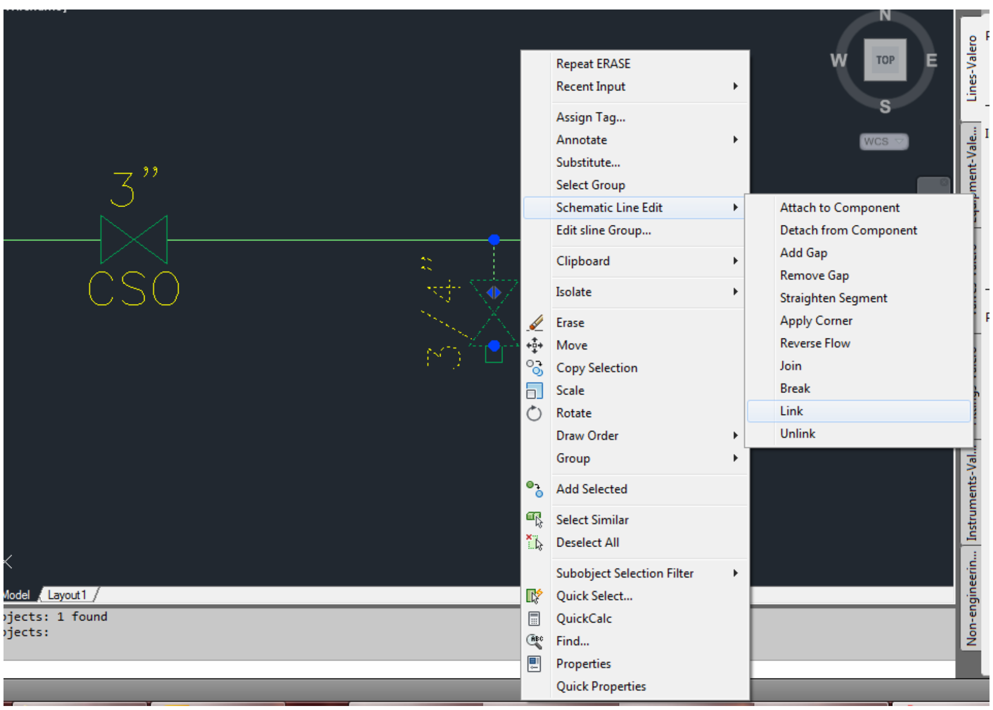
- Create new project using PIP template, accept defaults
- Edit project fields, name, address, etc.
- Edit project path (arbitrary in this case but need to have client input for location of project files and dwg files)
- Add client-specific properties to project
- Create .dwt file from client “rec’d” file
- Adjust project settings to match client standard
- Equipment callouts, size and order
- Pipe callouts, size and order
- Add any missing (client specific) blocks to project (i.e., insert into projsymbstyle.dwg and add to tool palette)
- Create fields for project name, number, address, etc. in .dwt
- Link project to .dwt file
- Turn off textmask (wipeout→frames→off)
- Change units
- Change Text styles
- Update reducer annotation to adjacent
- Fix annotation spacing
- Off page connectors
- For clients who utilize “Layout Tabs”:
    - Move border to paper space
    - Create viewport
    - Create vp guide in model space
    - Lock viewport

sP&ID Conversion

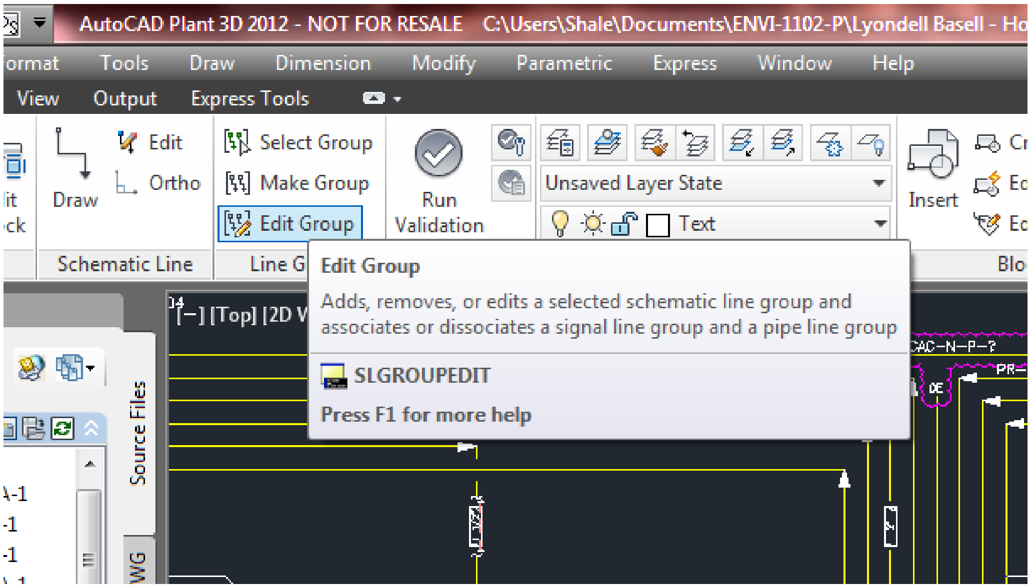
- Start “smart” drawing in project
- Open the Project Properties and Select the ‘EngineeringItems’ class.

- Add a new string property called ‘Stream’ to the ‘EngineeringItems’ class
- Save and Apply the changes.
- Insert “rec’d” file for reference (problem with nesting on first drawing)
- Convert equipment to P&ID objects
- Input e-tags for all equipment
- Locking existing piping and text layers to avoid accidental editing
- Miscellaneous items
- Ensure “Class” field is not left blank for any equipment

- In order to ensure proper connectivity, use the schematic line edit link command to modify individual s-lines that either have the same size as the large pipe segment.

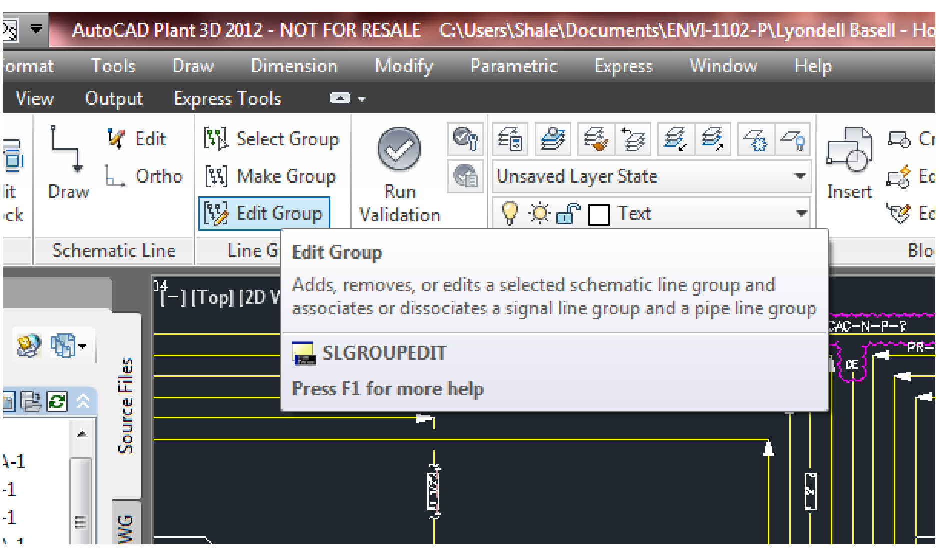


- If the short pipe segment is a known, different size from its host then “add” the short segment to the host segment using the line group commands to add or remove s-lines from a group.

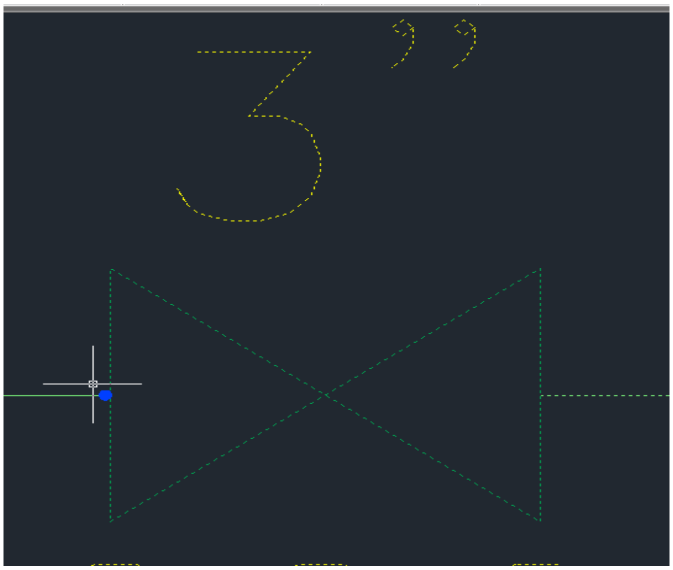


Specific P&ID Conversion Guidelines

- Use the line group commands to add or remove s-lines from a group. We are grouping process lines by LDAR speciation (see Section 4.5 for LDAR stream assignment guidelines).



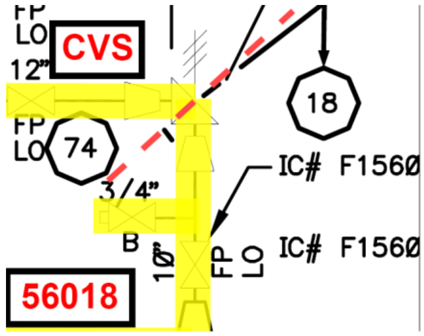
- If you have to “break” a line at a valve or other fitting, you must leave a miniscule length of pipe for “hosting” the valve or fitting. In other words, a break cannot occur exactly at the intersection of a process line and valve/fitting (see figure below).



- Upon breaking a process line you must re-tag the segment or link it to a host.
- Valves can be set to assume the stream speciation of the host process line.

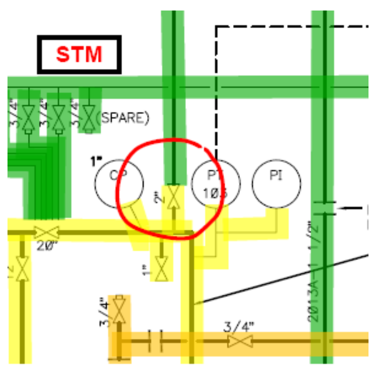
LDAR Stream Numbering Requirements

- Each PFD stream has been encoded with a LDAR Stream Number according to the following format of XXX-YYY where: XXX = Unit Number, YYY = Sequential number using leading zeroes as necessary.
- Using the marked-up PFDs as a guide, beginning updating the ‘Stream’ field located in the ‘Properties’ menu for lines and equipment that correspond with an encoded stream number.
- When it is difficult to tell where one stream ends and another begins, a light red dashed line may be used as in the example below:



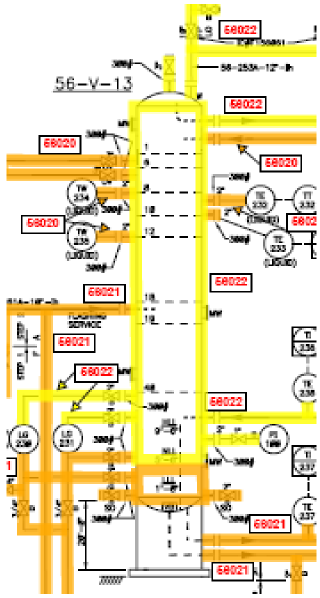
Red Dashed Line Used to Indicate Line Start/Stop Points

- When a regulated line intersects a non-regulated line, highlight that portion of the non-regulated line that is in contact with regulated process fluid. Usually this means highlighting back to the first check valve or block valve on the non-regulated stream. See the example below in which a block valve on a steam line is highlighted because it is in VOC Vapor Service:



Block Valve on Steam Line in VOC Service

- Equipment which has different phases at the top and bottom of the equipment should be marked in two colors showing the approximate dividing point of the liquid to vapor break, etc. Examples are vessels with liquid bottom and vapor top and sight glasses with liquid bottom and vapor top.



2 Phase Column Indicated