Data Consistency in Smart Instrumentation

Square Pegs and Round Holes

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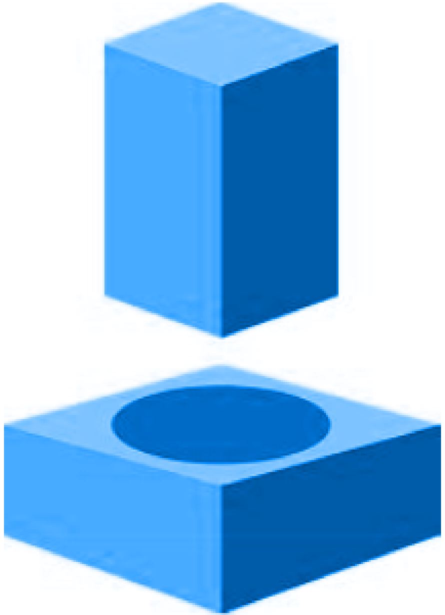
John Dressel, Fluor Fellow of
Smart Instrumentation

Data Inconsistencies in Smart Instrumentation

- Smart Instrumentation Data Consistencies
- Plant Hierarchy Naming Conventions
- Tag Number Naming Conventions
- Instrument Type Data Inconsistencies
- Range and Set Points Data Inconsistencies
- Units of Measure Data Inconsistencies
- Line Number Data Inconsistencies
- Process Data Inconsistencies
- Export / Import Data Inconsistencies
- DDP Data Inconsistencies



Smart Instrumentation Data Consistencies

- Smart Instrumentation Data Consistencies Methods
  - Pick Lists and Drop Down Data Windows
  - Minimize Redundant Data Across Tables
  - Modular Data Sets for Associated Data
- Modular Issues with Data Consistencies
  - Modules added to SI have different data sets
  - Different Modules display data with unique headers
- Complex Data fields results in Inconsistencies
  - Complex naming conventions leads to inconsistent data
  - Data flags result in complex mapping of data for integration

Plant Hierarchy Naming Conventions

- Users work at Lowest Hierarchy level so complex Plant Hierarchy may require users to switch units several time a day
- The Basis of the Hierarchy may be Process Unit, Operating System, Physical Unit or Construction Work Areas but should be kept simple
- Smart Instrumentation will not allow modifications to Plant Hierarchy after tags are assigned to Lowest Hierarchy
- The Plant Hierarchy must be consistent across all applications for integration to function when data is published and retrieved

Unit No.	System No.	Description
005	00	**Ziegler Alcohol Unit (existing)**
006	00	**ETO Unit (existing)**
007	00	**Ethylene Unit (existing)**
008	00	**Alumina Unit (existing)**
009	00	**Solvent Unit (existing)**
010	00	**Activated Sludge Unit (existing)**
012	00	**TET-1 Unit (existing)**
013	00	**TET-2 Unit**
013	10	*Catalyst System*
013	20	*Reactor System*
013	30	*Wash System*
013	40	*Flash and Recovery System*
013	50	*Polymer System*
013	60	*Product Distillation System*
013	80s	*Storage, Utility and Auxiliary Systems*
016	00	**Normal Paraffins Unit (existing)**
020	00	**EO/EG Unit**
020	10	*EO Reactor System*
020	20	*CO2 Reactor System*
020	30	*EO Stripping/Reabsorbtion System*
020	40	*EO Purification System*
020	50	*Glycol Reaction/Evaporation System*
020	60	*Glycol Drying System*
020	70	*Glycol Purification System*
020	80s	*Storage, Utility and Auxiliary Systems*
021	00	**LCLAB Unit (existing)**
022	00	**LCLAB-2 Unit**
030	00	**Ziegler-ALEX Unit**
030	10	*Aluminum Preparation System*
030	20	*Hydrogenation and Ethylation System*
030	22	*ATE Separation System*
030	30	*Growth Reaction System*
030	40	*Oxidation System*
030	42	*Alcoxide Stripping System*
030	50	*Solvent Splitter System*
030	55	*Alcohol Preparation System*
030	60	*Alcohol Distillation System*
030	80s	*Storage, Utility and Auxiliary Systems*
035	00	**Guerbet Alcohol Unit**
035	10	*Reactor System*
087	40	Guerbet Alcohol Storage System
087	50	TET-2 Storage System
088	00	**Miscellaneous Offsites and Utilities**
089		**Not Used**
090	00	**Infrastructure (Site Preparation / Temporary Facilities)**
091	00	**Roads**

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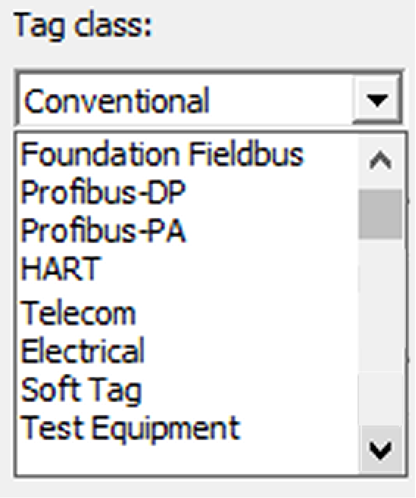
Tag Number Naming Conventions

- The Tag Naming Conventions should be based on a standard (e.g. ISA 5.1)
- The Tag Naming Conventions need to be consistent across all applications
- There are several Tag Classes and Naming Conventions and behaviors:
  - Instrument (Conventional) – most universal
  - Instrument (Foundation Fieldbus) – allows VFD and Function Blocks
  - Instrument (HART) – Limits I/O to HART AI and HART AO
  - Instrument (Profibus DP) – allows VFD and Function Blocks
  - Instrument (Profibus PA) – allows VFD and Function Blocks
  - Instrument (Telecom) – limits Instrument Types to Telecom
  - Instrument (Soft Tags) – should not be used for wired devices
  - Test Equipment & Electrical – Limits Data to General Process Function



Tag Number Naming Conventions

- It is necessary to have different Instrument Naming Conventions and Tag Classes for Systems or Instruments Types:
  - Machinery Protection Systems can have unique naming conventions:
    - Example: "27-VSH -C100-2000" where the equipment number is part of the Tag
  - Safety Systems where other groups are responsible for purchase or maintenance of devices (e.g. Relief Valves have unique naming convention)
    - Example: "POSRV-27-9000" Pilot-Operated Safety Relief Valve
  - Packaged equipment where the vendor has a unique naming convention
    - Example: "CV-100" non-ISA naming convention
  - Instruments that are purchased as coded items rather than tagged
    - Example: "PSG43005R1" (ASME bottom connected 300 psi pressure gauge)

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Tag Number Naming Conventions

- One way to create unique naming conventions without compromising the BPCS Key Tags is to create unique Units for Special Systems or Instrument Groups
  - Example: Inserting a 4-digit equipment number in a Machinery Protection Tag in Unit “21” by creating a new Unit number “210” with a Unit Number length of “2”

Segment Category	Seq.	Separator	Segment	Start	Length
Unit	1		UNIT NUMBER	1	2
Instrument Type	2		INSTRUMENT TYPE	1	5
Tag Number	3	-	EQUIPMENT	1	4
Tag Number	4	-	COMPONENT NUMBER	1	4
Tag Number	5		COMPONENT SUFFIX	1	3

BPCS Tag in Unit 21 – “21TSH -1000”

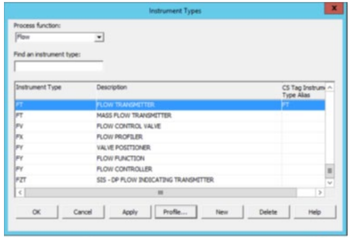
Equipment Tag in Unit 210 – “21TSH -C530-2001”

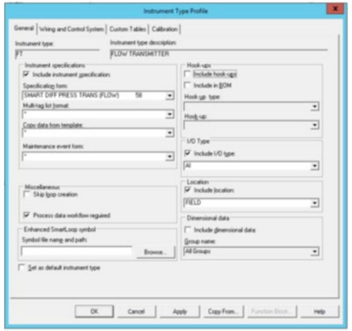
Tag Number Naming Conventions

- While Smart Instrumentation has multiple naming conventions, it should be noted that other applications only have one instrument naming convention
- Smart P&ID Naming conventions should drive Smart Instrumentation Tagging:
  - The Smart P&ID Legend sheets define naming conventions that define the Mechanical, Electrical, Process, Piping Lines and Instrument Systems
  - Smart P&IDs is the source of all project Master Tags and should have simple well defined Plant Hierarchy and Naming Conventions
  - To assure data consistency, Smart Instrumentation naming conventions should match the Plant Hierarchy and Naming Conventions in Smart P&ID

Instrument Type Data Properties Inconsistencies

- The Instrument Type Profile defines the automation functions and how data is distributed in the Smart Instrument database
- When an instrument is added to the database or the Profiles are launched the following actions will happen if the Profile Data is populated:
  - An Instrument Spec sheet is created and can be populated from a Spec Sheet Template
  - A Process Datasheet is created in the proper Process Function assigned to the Instrument Type
  - The I/O Type and Location are assigned
  - The Wiring Device Panel and Terminals are created
  - The Instrument cable is created and connected to the Device Panel
  - Other associations including Custom Tables, Power Requirements, Hook-ups, Dimensional Data for Piping and Loop Symbols are initialized





Instrument Type Data Properties Inconsistencies

- Instrument Type Data Properties are pick lists to maintain data consistencies, but the pick lists can be modified to include data that are not consistent with the initial purpose of the property
  - **Tag Class:** Pick List defined by the Naming Conventions - Used to select the naming convention used for the Master Tag Numbers
  - **Service:** String describing the service description of a tag – May be inherited from the Loop service Description
  - **Instrument Type:** Pick List used to define the Automation Profile – Composed of Instrument Function, Description and Process Function
  - **Status:** Pick List defining the status of an instrument – e.g. New, Furnished, Relocated, Deleted etc..
  - **Location:** Pick list defining the physical location of an Instrument – May be general such as “Field” or more exact such as “Inline or Offline”

Instrument Type Data Properties Inconsistencies

- **I/O Type:** Pick list used to define the type of connection to a DCS or PLC – Should not be modified if you are using a DCS Vendor Interface – If required “System” or “Signal Type” can be defined in other places, also “Soft” is not a valid I/O Type
- **Instrument Certification: Pick List** used to define any standard certifications required for procurement or installation of the instrument
- **Signal Type: Pick List** used to define the signal or protocol used by an instrument – May be used to define Soft Tags or special Protocols
- **Linear Type: Pick List** used to define the instrument calibration of an analog control signal – Usually defined as Linear, Non-Linear, Logarithmic or Exponential
- **Equipment: Pick List** selection of the Equipment Number that an instrument is mounted on or in – **Not associated to!**
- **Line: Pick List** selection of the Line Number that an instrument is mounted on or in – Line Only the Line Size and Spec are needed for instrument sizing

Instrument Type Data Properties Inconsistencies

- **P&ID: Pick list** used to select the source Piping and Instrument Diagram showing the Instrument – May be other source documents
- **Manufacturer: Pick List** used to select the Manufactures name of an instrument – Different spellings and case causes issues in this table
- **Model: Pick List** used to select me model number based on a parent relationship to the manufacture – catalog numbers may be used
- **Intrinsically safe circuit type: Pick List** used to select the method of making an instrument incapable of igniting an explosive atmosphere
- **On and Off signal state:** a description of what state an instrument will be in when the signal is on and off
- **Requires power supply:** a check box that turns on a Power Supply tab enabling the user to define the power requirements

Range and Set Points Data Inconsistencies

- Only Hard Instrument Ranges and Switch or Solenoid Trips should be documented in Smart Instrumentation
- Each Process Function has Ranges and Set Points defined and associated with the Transmitter Signal in Smart Instrumentation
- All Range, Alarms and Trip fields are available and editable in EDE views
- Soft Range and Alarm Set Points are not normally documented in Smart Instrumentation but are typically documented in the HMI of the DCS system and programmed as part of the DCS configuration
- If Alarm set points are entered in Smart Instrumentation, they must match the DCS set points to eliminate having conflicting data in separate places
- Users should **NOT** create UDFs for Alarms that are already defined in the Smart Instrumentation data dictionary is it could result in inconsistent data in two places

Range and Set Points Data Inconsistencies

- Ranges assigned to the Instruments are available from any Instrument or Control Systems Tag EDE View
  - Calibration Ranges are factory bench calibration settings
  - DCS Range is the predicted DCS configuration settings
  - Instrument Ranges are provided for vendor Sizing and Selection

SI DATABASE FIELD NAME	EDE PROPERTY DESCRIPTION
CALIB_RANGE_MAX	Calibration Range Maximum
CALIB_RANGE_UOM_MAX	Calibration Range Maximum Units
CALIB_RANGE_UFLG_MAX	Calibration Range Maximum Units Flag
CALIB_RANGE_MIN	Calibration Range Minimum
CALIB_RANGE_UOM_MIN	Calibration Range Minimum Units
CALIB_RANGE_UFLG_MIN	Calibration Range Minimum Units Flag
DCS_RANGE_MAX	DCS Range Maximum
DCS_RANGE_MIN	DCS Range Minimum
DCS_RANGE_UOM	DCS Range Maximum Units
DCS_RANGE_UFLG	DCS Range Maximum Units Flag
INST_RANGE_MAX	Instrument Range Maximum
INST_RANGE_UOM_MAX	Instrument Range Maximum Units
INST_RANGE_UFLG_MAX	Instrument Range Maximum Units Flag
INST_RANGE_MIN	Instrument Range Minimum
INST_RANGE_UOM_MIN	Instrument Range Minimum Units
INST_RANGE_UFLG_MIN	Instrument Range Minimum Units Flag

Range and Set Points Data Inconsistencies

- Alarm and Trips associated to the Control Systems Tags are available from the Control Systems Tag EDE View
- Eight Calibration Settings are available for Six Alarms and Trips for Hi, HiHi, HiHiHi, Lo, LoLo, LoLoLo Properties
- Control System Alarm Tags are for Transmitter I/O Tags and are Not DCS HMI Soft Tags

DATABASE FIELD NAME	CONTROL SYSTEM PROPERTY DESCRIPTION
CALIBRATION_SETTING.TRIP_SET_DESC	1st thru 6th Alarm / Trip Point Description
CALIBRATION_SETTING.TRIP_SET_DIR	1st thru 6th Alarm / Trip Point Direction
CALIBRATION_SETTING.TRIP_SET_MAX	1st thru 6th Alarm / Trip Point Max Value
CALIBRATION_SETTING.TRIP_SET_MIN	1st thru 6th Alarm / Trip Point Min Value
CALIBRATION_SETTING.TRIP_SET VALUE	1st thru 6th Alarm / Trip Point Type
CALIBRATION_SETTING.TRIP_SET_POINT	1st thru 6th Alarm / Trip Point Value
CALIBRATION_SETTING.TRIP_SET_UOM	1st thru 6th Alarm / Trip Unit of Measure
CALIBRATION_SETTING.TRIP_SET_UOM_UFLG	1st thru 6th Alarm / Trip Unit of Measure Flag
ALARM_HIGH	Control System Tag Alarm High
ALARM_HIGH_HIGH	Control System Tag Alarm High-High
ALARM_LOW	Control System Tag Alarm Low
ALARM_LOW_LOW	Control System Tag Alarm Low-Low
ALARM_UOM_CODE	Control System Tag Alarm Unit of Measure

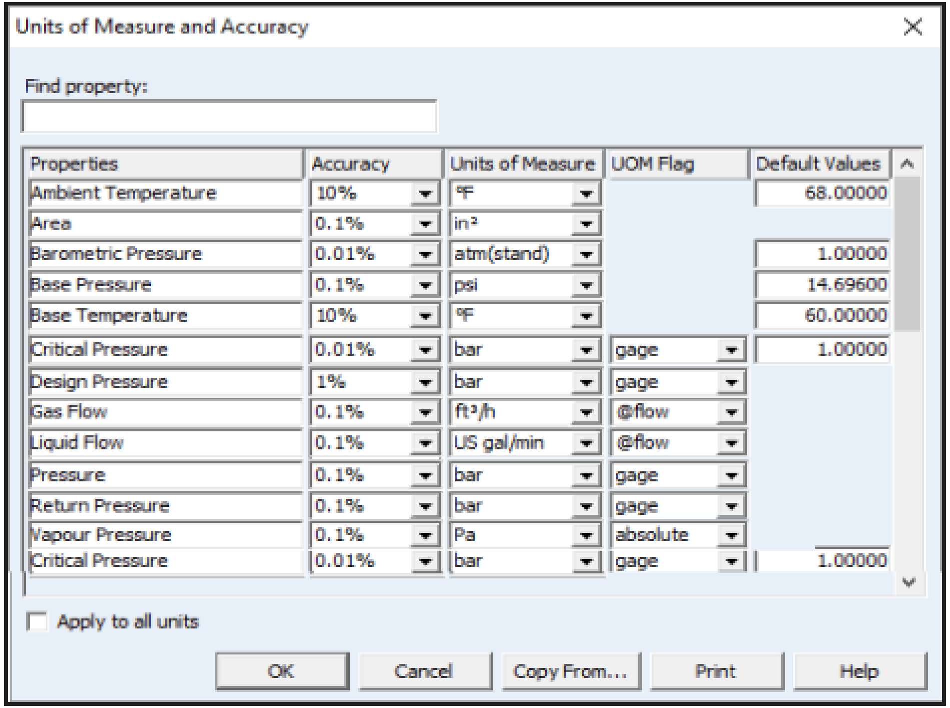
Range and Set Points Data Inconsistencies

- Process Design Conditions are established from the Piping Line Class Spec or Equipment Trim
- Process Data Base and Ambient Ranges are available in the General Process Data EDE View
- Each Process Function has a complete set of Ranges, Alarm and Trips access with EDE views for Analyzer, Flow, Level, Pressure, Relief Valve and Temperature Functions

DESIGN CONDITION FIELD NAME	DESIGN CONDITION DESCRIPTION
PD_PRESS_DES	Design Pressure Maximum
PD_PRESS_DES_MIN	Design Pressure Minimum
PD_PRESS_DES_MIN_FLG	Design Pressure Minimum Unit of Measure Flag
PD_PRESS_DES_MIN_UID	Design Pressure Minimum Unit of Measure
PD_PRESS_DES_UFLG	Design Pressure Maximum Unit of Measure Flag
PD_PRESS_DES_UID	Design Pressure Maximum Unit of Measure
PD_RETURN_PRES_DESIGN	Design Return Pressure
PD_RETURN_PRES_DESIGN_UFLG	Design Return Pressure (Gage / Absolute)
PD_RETURN_PRES_DESIGN_UID	Design Return Pressure Unit of Measure
PD_RETURN_TEMP_DESIGN	Design Return Temperature
PD_DESIGN_TEMP_MAX	Design Temperature Maximum
PD_DESIGN_TEMP_MIN	Design Temperature Minimum
PD_DESIGN_TEMP_UID	Design Temperature Unit of Measure

Units of Measure Data Inconsistencies

- Units of Measure that are defined in the "Units of Measure and Accuracy" table
  - **Properties** is the name of the UOM
  - **Accuracy** is the number of displayed characters
  - **Units of Measure** is the displayed value
  - **UOM Flags** are additional properties
  - **Default Value** is used for Unit Conversion and initial display value
- **Note: The Unit of Measure and Unit of Measure Flag may conflict with the DCS or Vendor Unit of Measure Codes**



Units of Measure and Accuracy

Find property:

Properties	Accuracy	Units of Measure	UOM Flag	Default Values
Ambient Temperature	10%	°F		68.00000
Area	0.1%	in^2		
Barometric Pressure	0.01%	atm(stand)		1.00000
Base Pressure	0.1%	psi		14.69600
Base Temperature	10%	°F		60.00000
Critical Pressure	0.01%	bar	gage	1.00000
Design Pressure	1%	bar	gage	
Gas Flow	0.1%	ft^3/h	@flow	
Liquid Flow	0.1%	US gal/min	@flow	
Pressure	0.1%	bar	gage	
Return Pressure	0.1%	bar	gage	
Vapour Pressure	0.1%	Pa	absolute	
Critical Pressure	0.01%	bar	gage	1.00000

Apply to all units

OK | Cancel | Copy From... | Print | Help

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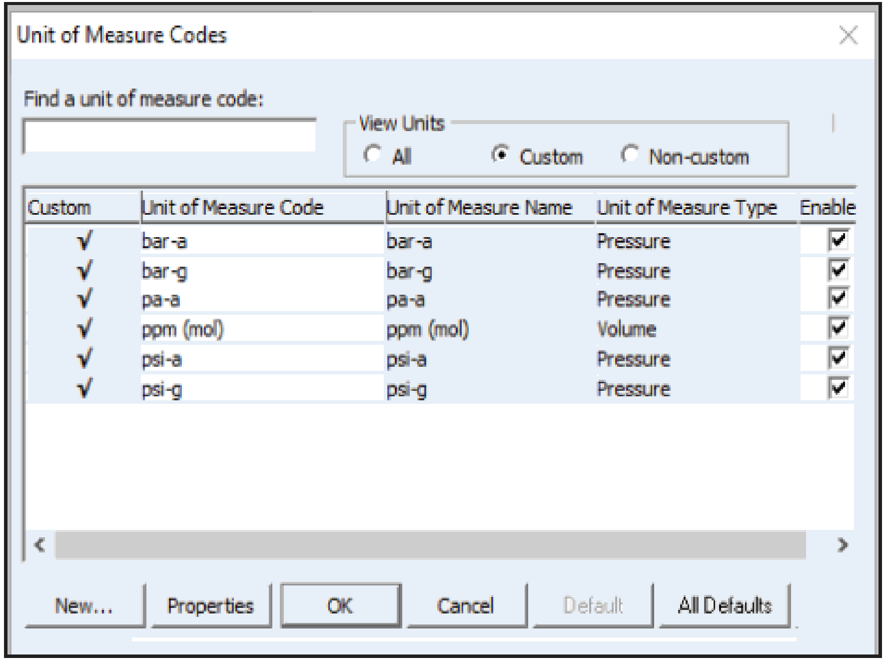
Units of Measure Data Inconsistencies

- Smart Instrumentation allows users to add custom **Unit of Measure Codes** to the Unit of Measure Tables
- From the “Tools” menu, select “Unit of Measure Codes” then select the Custom View Units to create New Unit of Measure Codes
- Some examples of Unit of Measure Codes are: “**psi-a**” and “**psi-g**”
- Use custom Unit of Measure Codes in Specs and EDE views to simplify exporting Units of Measure that are consistant with external requirements



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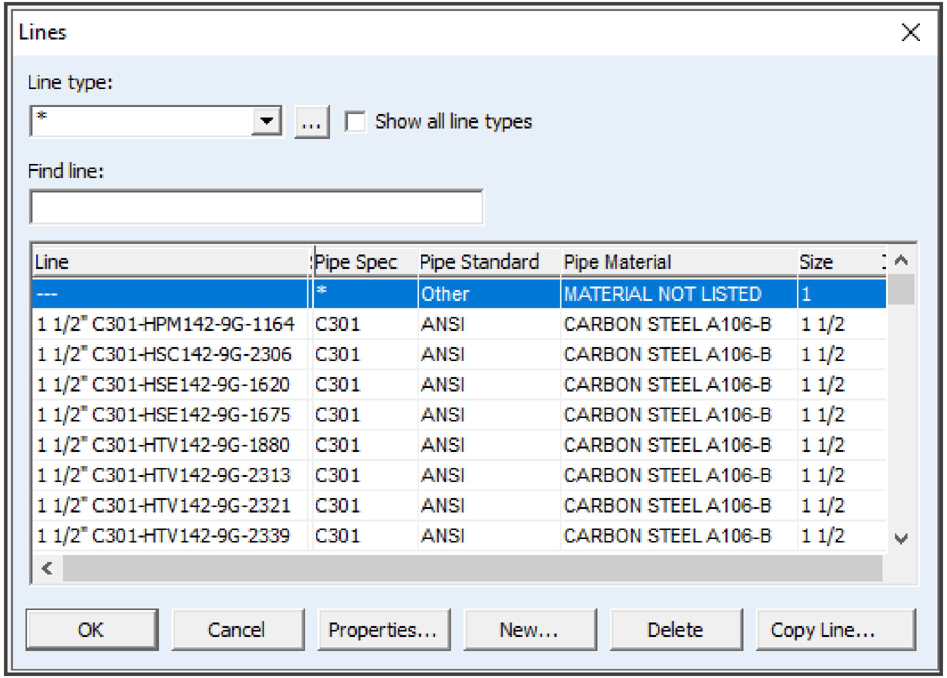
Line Number Data Inconsistencies

- The Line Number table is complex and a gathering place for Inconsistent Data
- The use of "Line Type" is confusing and serves no purpose
- The "Find Line" is useless as it starts with Line Size then the exact full line number
- Only Lines that have instruments in them should be placed in the Line Table
- Line Properties are edited one at a time against Pipings Line Class Spec
- Realistically - Only the Size and Spec are needed for instrument sizing and the complete line number is not needed



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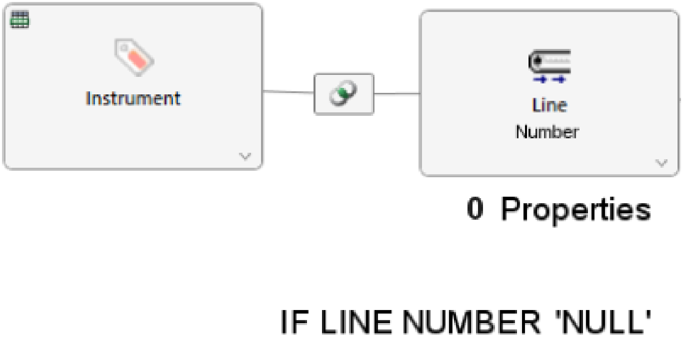
Line Number Data Inconsistencies

- The use of “space” or “-- ” or “NA” in the Line Number increases the size of the database
- “Purpose of a ‘NULL’ value” – A ‘NULL” value stops a query from engaging additional Foreign Keys
- Any value in a key field including “space” or “--” or “NA” continues the Query and adds additional properties to **every Instrument Tag in the database that do not have Line Numbers**



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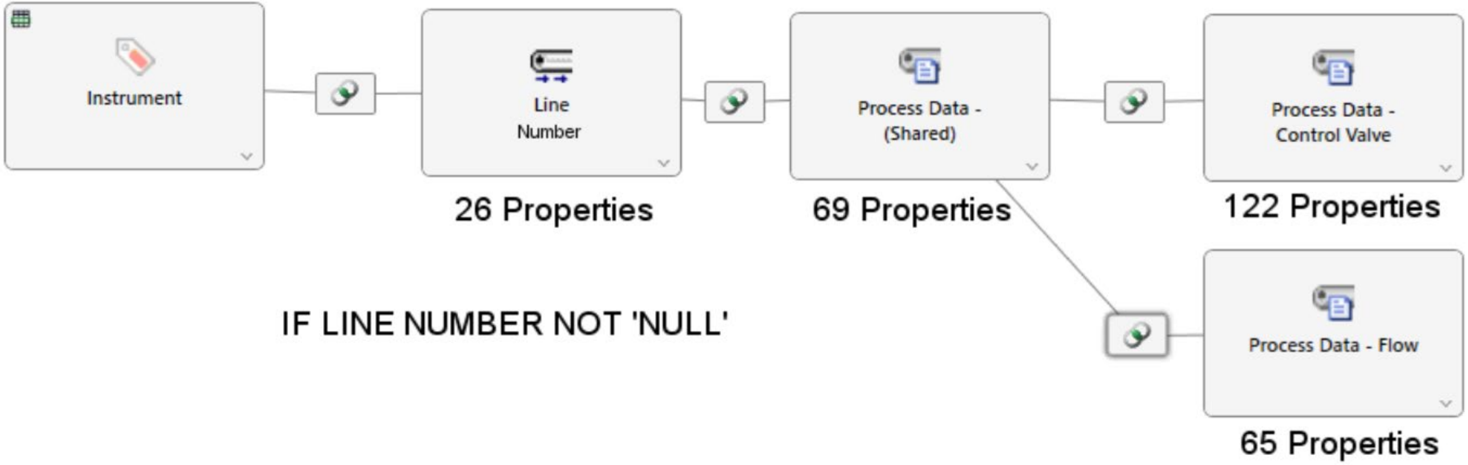
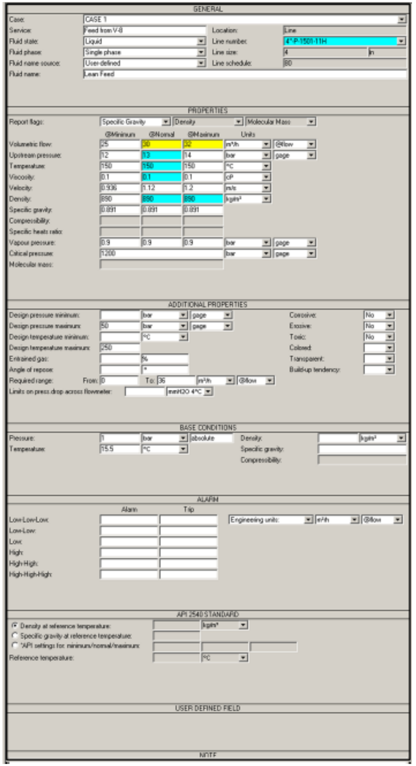


Process Data Inconsistencies

- The Process Data is not a project deliverable to the Client on most projects
- The Primary Process Customer is Control Systems for the Sizing and Calibration of the Inline Instrument devices
- Because of the Critical and Dynamic nature of process data it is important that Change Management Procedures be in place on every project
- Process Module is used to enter data directly into Smart Instrumentation for Calculations and Instrument Spec Sheets



Process Data Inconsistencies

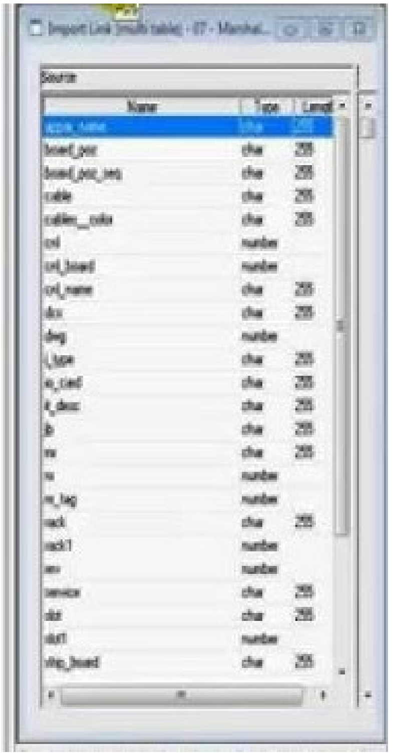
- Maintaining Process Data consistency in Smart Instrumentation
  - Utilize the "Process Workflow" to control who loads process data and Management of Change
  - Process Engineers load data directly into Smart Instrumentation to maintain ownership of the data
  - Utilize functions and features in the process module for data consistency:
    - Built-in Fluid properties lookups for chemicals and hydrocarbons
    - Conversion of Process data when changing Unit of Measure
    - Data validation (e.g. Stream must be above 100 degree C)
    - Copy Process data from lines and other Tags

Export / Import Data Inconsistencies

- **Export Utility**
  - EDE “Save as” function is used to export data to external applications
  - The EDE views uses alias headers to identify the data columns
  - Reference data like Record ID and table names are not available in EDE views
- **Import Utility**
  - The import Utility is used to import data from external applications
  - The import Utility uses actual Table and Field names when mapping data links
  - The import Utility uses key fields (Tag Name, etc.) as the basis for data import
- **Data Inconsistencies**
  - The biggest issue is the header name mismatch requiring additional mapping data to be provided for external application for data import or export

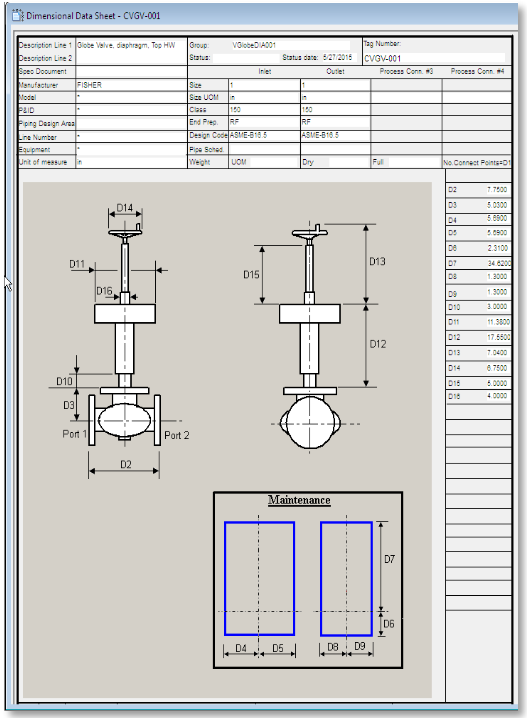
Export / Import Data Inconsistencies

- The most successful Import source file is Microsoft Excel
- The source file should be cleaned to match the Smart Instrumentation data fields for:
  - loop and Tag naming conventions
  - Units of Measure code names and flags
  - Supporting Table information (e.g. Instrument Types)
- The Import Tag/Loop Definition should always define the naming convention in the link for Index imports
- The Import Comparison Option can only be used with Table imports



DDP Data Inconsistencies

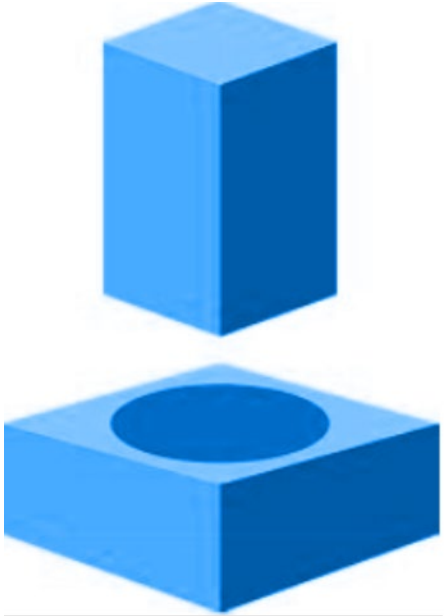
- The DDP utility was developed by KBR and was integrated into SPI in 2002
- The DDP module Data Tables were not part of the original INtools Data Dictionary
- The DDP Tables do not map directly to the Smart Instrumentation Tag numbers
- There is an EDE view of DDP data, but it is read only
- To edit DDP data users must use the DDP Browser
- There are DDP fields that would be useful in Instrument Specs and Indexes (e.g. End Prep)



Summery of Smart Instrumentation Data Consistencies

- In a Smart Instrument data dictionary, every Table and Trigger has a specific purpose and is intended to contain data that is relevant to that purpose
- Inconsistent data can also affect the performance of the database
- Examples of Inconsistent or Garbage in a Smart Instrumentation database:
  - Unstructured or Duplicate Key values in primary tables or fields
  - Data that does not fit the purpose of a field (e.g. a numeric value in a character field such as “Name”)
  - Data that violates the purpose of a “Null” value in a table Key Field
  - Use of a User Defined Fields to duplicate a field already defined in the Smart Instrumentation data dictionary
  - Narratives or Notes used in place of valid data fields

Smart Instrumentation Data Consistencies



QUESTIONS?

"Errors using inadequate data are much less than those using no data at all"

~ Charles Babbage

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