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INTRODUCTION

There is a need for a standard method of classification for instruments and controls that goes beyond a tagging philosophy. A grouping by type is required for a number of reasons including Specification, Purchase, Data Collection, and Failure Analysis.

The Specification of instruments and controls requires that like-kind devices be grouped together. After the identification of what devices are required, this grouping is the first step in organizing a job. Even small jobs can have a thousand tags; large jobs - tens of thousands. The tag number alone does not provide enough information to classify a device for specification. For example, a Flow Element, (FE), can be an orifice plate or a turbine meter. These diverse instrument types do not go onto the same data sheet and might not be assigned to the same engineer.

This logical grouping of devices carries into the procurement process. Enquiries must be grouped by type and given to suppliers who can respond without exception or buyout. For example, some suppliers of control valves do not offer self-contained regulators, triple-offset valves, or ball-type control valves. Grouping all control valves together for purchase can result in a no-bid situation or many exceptions. This may seem like common sense, and one would assume that engineering contractors do not make this error, but it happens with alarming frequency.

The Data Collection issue associated with grouping by type is twofold.

First, during the procurement process, initial Data Collection takes the form of descriptive documentation of the device, tests, and required certificates. Often Engineering companies start each job anew. They may boast of standard software, but it seldom serves the purpose. The job of assigning a device type is often arbitrary. Even if a good proprietary standard exists with one engineering contractor, it is not useful to an operating company dealing with many contractors. The result of this lack of a universal standard is a failure to consistently gather the required data both in the procurement process and during plant operations. When a facility is accepted by an operational group, they often face the daunting task of converting what they received into their own software. This process is never easy, seldom accurate, and often incomplete.

Second, after the device is placed in service, Data Collection is critical to operations and maintenance. The application of more successful device types to certain processes and conditions will reduce the frequency of costly shutdowns. Safety is also a benefit. The application of the right device to the right service based on known results yields a safer plant. Maintenance frequency optimization is yet another benefit.

All data collected should be device specific and well defined in advance. If the data required for a specific device type was predefined, it would save untold man-hours during engineering and procurement, and it would provide for a smooth transition from Contractor to Operating Company.

Why is this all this standardized data important? Failure Analysis is the primary answer – Safety and Uptime have a tremendous valve to any operating company.

- Data without organization has little value and is often counterproductive.
- Standardized data within a business unit has some value.
- Standardized data across business units within a Company has great value, and...
- A standard by which data can be analyzed for an Industry or Industries has tremendous potential.

Sadly, few companies achieve standardization across business units. The first step in organizing data is to have a standard description, or Taxonomy, for the various and numerous types of instruments and controls. There is currently no pervasive and universal system for classification available.

EXISTING STANDARDS

ISO-14224 addresses the need for standardization for equipment types, and it touches on Instruments and Controls. This ISO Standard defines Classes and Types that can be applied to some Instruments & Controls. These are:

Process Sensors	
• Pressure	• Vibration
• Level	• Displacement
• Temperature	• Analyzer
• Flow	• Weight
• Speed	

Control Logic Units	
• PLC	• Relay
• Computer	• Solid State
• DCS	• Single Loop Controller

Fire & Gas Detectors	
• Smoke/Combustion	• Gas – HC
• Heat	• Gas – H2S
• Flame	

Other Classes include "Valves", (most types including relief valves), "Nozzles", and "Subsea Controls – Hydraulic".

It can be readily seen that this ISO does not go far enough. For example, a Process Sensor for pressure can be a switch, a gage, or a transmitter. If it is a transmitter, it can be several types of digital and several types of analog. A switch can be of several distinct types with numerous output types.

ISA also defines some types.

ISA-S5.1 provides commonly accepted guidelines for tagging instruments. However tag numbers define instrument function but not instrument type. Because tag numbers are always used and commonly understood, they are often misused as pseudo-types. For example, on a current project with a major engineering contractor, proprietary software grouped instruments for purchase by types that mimicked the tag number. The results were costly – this is all too often the case.

ISA also provides a breakdown of instruments for specification most recently in TR-20.00.01-2001. This standard assigns specification form numbers to devices (device types). This breakdown of types by form comes closer to taxonomy but it is incomplete, and it does not provide the required flexibility.

A standard method of classification by type is required.

TAXONOMY SYNTAX

A five letter code is presented that will provide a basic classification that can be applied to all devices. Each letter would sequentially represent Equipment Class, Operating Parameter, Device Type, and two additional Parameters. This process should define a device type to a point just above the manufacturer and specifications such as material type. It is not practical for any Classification method to specify a device. There has to be a breakpoint between Taxonomy and specification. The following examples demonstrate how detailed you can get with a simple 5-letter code.

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Process Sensor Example

Equipment Class

A single letter code defines the Class. The ISO Class codes are shown for reference.

Equipment Class	ISO Code	Proposed
Process Sensors	PS	S
Control Logic Units	CL	L
Fire & Gas Detectors	FG	n/a
Valves	VA	V
Subsea Controls - Hydraulic	CS	n/a
Nozzles	NO	n/a
Analyzer *	n/a	A

* Analyzer is an ISO Type and not a Class

The reason no proposed Class is offered for several of the ISO categories is because these Classes can and should be moved into the other Classes. A gas detector, for example, is a Sensor. It can be distinguished as a safety device elsewhere in the taxonomy. Also, a nozzle is a flow orifice.

The following is an example of a taxonomy that will be progressed through this narrative.

S				

Note: The "S" in first field of the taxonomy example is for Process Sensor.

Operating Parameter

The Operating Parameter is the measured variable and would generally correspond to ISA's Device Specification Categories as defined in S-5 and S/TR-20.

Parameter	ISO Type Code	Proposed
Pressure	PS	P
Level	LS	L
Temperature	TS	T
Flow	FS	F
Speed	SP	S
Vibration	VI	V
Displacement	DI	D
Weight	WE	W
Burner or Combustion	n/a	B
Position	n/a	Z
Density	n/a	G
Voltage	n/a	E
Current	n/a	I
Power	n/a	J
Time	n/a	K
Radiation	n/a	R

Other Parameters would include pH, turbidity, et cetera. A complete listing might require an extended code such as X01 – X99. The use of the letter "X" could always represent special coding wherever it was used.

The "P" in the second field of the taxonomy example is for "Pressure".

S	**P**			

Device Type

This Code is similar to the familiar ISA S5.1 "Output Function. This Device Type would be defined on the various Taxonomy Sheets for each Class and Type.

The "T" in the third field of the taxonomy example represents "Transmitter".

S	P	**T**		

Device Parameter 1

This Code modifies the Device Type and would be specific to the Type as defined on Taxonomy Sheets.

The "G" in the fourth field of the taxonomy example represents "Gage Pressure".

S	P	T	**G**	

Device Parameter 2

This Code can modify the Device Type or the first Device Parameter. It would be defined on the Taxonomy Sheets.

The "F" in the fifth field of the taxonomy example represents "Foundation Fieldbus".

S	P	T	G	**F**

Process Sensor Summary

In the example above, a Gage Pressure Transmitter utilizing Foundation Fieldbus is described. The only thing not defined at this point is the manufacturer and certain other parameters specific to the data sheet such as range and materials of construction. However, the Taxonomy gives us sufficient detail to group for specification, procurement, vendor data collection, and process data collection. It is a simple enough task to add additional fields as required. For Example:

S	P	T	G	F	-	1	A

"1" could represent the manufacturer and "A" any other parameter a Company requires such as "Service". These additional codes or parameters would be Company defined and not Standards based. With this classification, an Operating Company could eventually compare failure rates between Manufacturer 1 and 2 for a given device type and Service.

Here are some additional examples.

SPSDS	Process Sensor, Pressure Switch, Diaphragm with Standard Contact
SFEOR	Process Sensor, Flow Element, Orifice Plate, Restriction (for permanent pressure drop)
STETJ	Process Sensor, Temperature Element, Thermocouple, Type J

See the appendices for more detail.

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Control Logic

Without going into the detail above, (because examples will be presented), it should be apparent that "Sensors" are Inputs and "Control Logic" is output, a calculation, or some similar device or function. An alarm on a control room monitor in a DCS can be generated by many different types of sensors and yet be of the same type. A pressure alarm high, (PAH), and a level alarm high, (LAH), are of the same type if they exist in a common device. A PAHH and a TAHH could of the same type if they were in the same equipment, but they would be distinct from the PAH example. The measured variable is not important to defining type and yet it is often included thus clouding the issue and creating multiple names for the same device type.

Here are several examples of Control Logic.

CLAHA	Control Logic, SIS System, Alarm High High, ESD Level 0
CRPEF	Control Logic, Relay, Positioner, Electronic, Foundation Fieldbus

See the appendices for more detail.

Control Valves

Valves, including actuators, are final control elements that are operated by Control Logic devices such as positioners. ISO 14224 defines valve types – here are some examples.

Valve Form Factor	**ISO Type Code**
Ball	BA
Globe	GL
Butterfly	BP
Plug	PG
Needle	NE
Diaphragm	DI
Eccentric Disc	ED
3-Way	WA
PSV – Conventional	SC
PSV – Bellows	SB
PSV – Pilot	SP
PSV – Vacuum	SV
Shuttle	SH

The Taxonomy for valves presented in Appendix C generally follows the ISO. Another approach would be to classify types more generally; for example, quarter turn, sliding stem, pressure relief, and self contained regulator. Further breakdown would be by Type and Parameters.

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SUMMARY

The Taxonomy presented here is by no means complete, but it provides a flexible framework that demonstrates the ability to develop Taxonomy. A detailed Taxonomy for Process Control and Instrumentation is needed. No complete and/or generally accepted taxonomy standard exists.

A Taxonomy standard for instruments and controls would provide a means to simplify the grouping of instruments for Specification, for Procurement, and for Data Collection. The result of implementing such a standard would facilitate:

- Failure Analysis to increase safety and plant uptime.
- Cost and schedule savings during engineering design and procurement. (Based on lessons learned on a current project, these savings can be significant.)
- Ease of data handover from Contractor's software to Operating Company software.

A broad base of uniform data can only be achieved with standardization.

In order for any taxonomy standard to be effective, it must be well defined, generic, and comprehensive. It also must provide a standard based framework for user defined flexibility.

Most "work" now is computer based. Instrument and Control work is often "list management". In other words, it is database intensive. The tagging standard is well defined and adequately provides for the unique field that database software requires. If "Type" was defined as well as "Tag" then several industries would benefit in the areas of Safety, Cost, and Schedule.

Equipment Class	Equipment Type	Device Type	Device Parameter 1	Device Parameter 2	Appendix A PROCESS SENSORS (Pressure Example) PRESSURE	Notes
S	Process Sensor					Corresponds to ISO Class Code PS
	P	Pressure				Corresponds to ISO Type Code PS
		S	Switch			
			D	Diaphragm		
			P	Piston		
				F	Fieldbus	
				H	Hydraulic	
				N	Pneumatic	
				P	Profibus	
				S	Standard contact	SPST, DPDT, Form 'C', etc.
S	P	T	Transmitter			
			A	Absolute Pressure		
			D	Differential Pressure		
			G	Gage Pressure		
			V	Vacuum		
				A	Analog	4-20 mA, 1-5 V, etc.
				F	Fieldbus	
				H	HART	
				N	Pneumatic	
				P	Profibus	
S	P	I	Indicator			
			E	Electronic		
				A	Analog	
				D	Digital	
			G	Gage		
				B	Bourdon Tube	
				D	Diaphragm	
				H	Helix	
			D	Differential		
				B	Bellows	
				C	Coupled Magnetic Piston	
				D	Diaphragm	
				M	Mercury	

Equipment Class	Equipment Type	Device Type	Device Parameter 1	Device Parameter 2	**PROCESS SENSORS (Flow Example)** FLOW	Notes
S	Process Sensor					Corresponds to ISO Class PS
	F	Flow				Corresponds to ISO Type FS
		E	Element			
			O	Orifice Plate		
				F	Flow Measurement	
				R	Restriction Orifice	Permanent pressure drop.
			T	Turbine Meter		
			M	Magnetic		
			D	Positive Displacement		
			P	Pitot Tube		
			V	V-Cone		
			C	Coriolis		
			S	Straightening Vane		
				F	Flanged	
S	**F**	**S**	Switch			
			I	Intrusive		Paddle type
				F	Fieldbus	
				H	HART	
				N	Pneumatic	
				P	Profibus	
				S	Standard contact	SPST, DPDT, Form 'C', etc.
S	**F**	**T**	Transmitter			Excludes dP transmitters: see "Pressure"
			E	Electronic		
				A	Analog	4-20 mA, 1-5 V, etc.
				F	Fieldbus	
				H	HART	
				P	Pulse	

Equipment Class	Equipment Type	Device Type	Device Parameter 1	Device Parameter 2	PROCESS SENSORS (Temperature Example) TEMPERATURE	Notes
S	Process Sensor					Corresponds to ISO Class Code PS
	T	Temperature				Corresponds to ISO Type Code TS
		E	Element			
			B	Bi-metallic		
			F	Filled		
				A	Class IA	
				B	Class IB	
				C	Class IIA	
				D	Class IIB	
				E	Class IIC	
				F	Class IIIA	
				G	Class IIIB	
				H	Class VA	
				I	Class VB	
			R	Resistance Temperature Device		
				A	Platinum, 100 Ohm	
			T	Thermocouple		
				E	Chromel / Constantan	
				J	Iron / Constantan	
				K	Chromel / Alumel	
				R	Rhodium / Platinum 13%	
				S	Rhodium / Platinum 10%	
				T	Copper / Constantan	
S	**T**	**W**	Well			
			F	Flanged		
				A	Single piece construction	
				B	Two piece construction	
			S	Screwed		
S	**T**	**S**	Switch			Specify the TE separately
			B	Bi-metallic input		
			F	Filled input		
				F	Fieldbus	
				N	Pneumatic	
				P	Profibus	
				S	Standard contact	SPST, DPDT, Form 'C', etc.

Appendix B
CONTROL LOGIC

Equipment Class	Equipment Type	Device Type	Device Parameter 1	Device Parameter 2		Notes
C	Control Logic					Corresponds to ISO Class Code CL
	L	Shutdown Service or SIS				Corresponds to ISO Type Code LC
		A	Alarm			
			H	High High		
				A	ESD Level 0	
				B	ESD Level 1	
				C	ESD Level 2	
				E	Unit Shutdown	
			L	Low Low		
				A	ESD Level 0	
				B	ESD Level 1	
				C	ESD Level 2	
				E	Unit Shutdown	
C	D	Process Control System				Corresponds to ISO Type Code DC
		C	Loop Controller			
			P	PID - Proportional, Integral, Deriv.		
			M	MPC - Model Predictive Control		
			F	Fuzzy Logic		
C	D	G	Graphic			
			A	Alarm		
				H	High	
				L	Low	
			I	Indication or Status		
				A	Analog	
				D	Discrete	
C	D	K	Calculation			
			D	Discrepancy		

Equipment Class	Equipment Type	Device Type	Device Parameter 1	Device Parameter 2	Appendix C VALVES	Notes
V	Valves					Corresponds to ISO Class VA
	B	Ball				Corresponds to ISO Type BA
		A	Actuated			
			C	Control		Variable Control
				S	Standard Ball	
				V	Segmented-Ball	
				T	Noise or Cavitation Trim	
			S	Safety		
				S	Shutdown	
				B	Blowdown	
			Y	Switching, On-Off Service		
V	B	H	Hand Operated			
			C	Control		
				S	Standard Ball	
				V	Segmented-Ball	
				T	Noise or Cavitation Trim	
			Y	Switching, On-Off Service		
V	G	Globe				Corresponds to ISO Type Code GL
		A	Actuated			
			C	Control		
				S	Standard Plug	
				C	Cage	
				T	Noise or Cavitation Trim	
			S	Safety		
				S	Shutdown	
				B	Blowdown	
V	G	H	Hand Operated			
			C	Control		
				S	Standard Plug	
				C	Cage	
				T	Noise or Cavitation Trim	