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Practical use of ISO 15926

Session 3
The “modelling process”
with example
“ambient operating temperature”

June 7, 2011

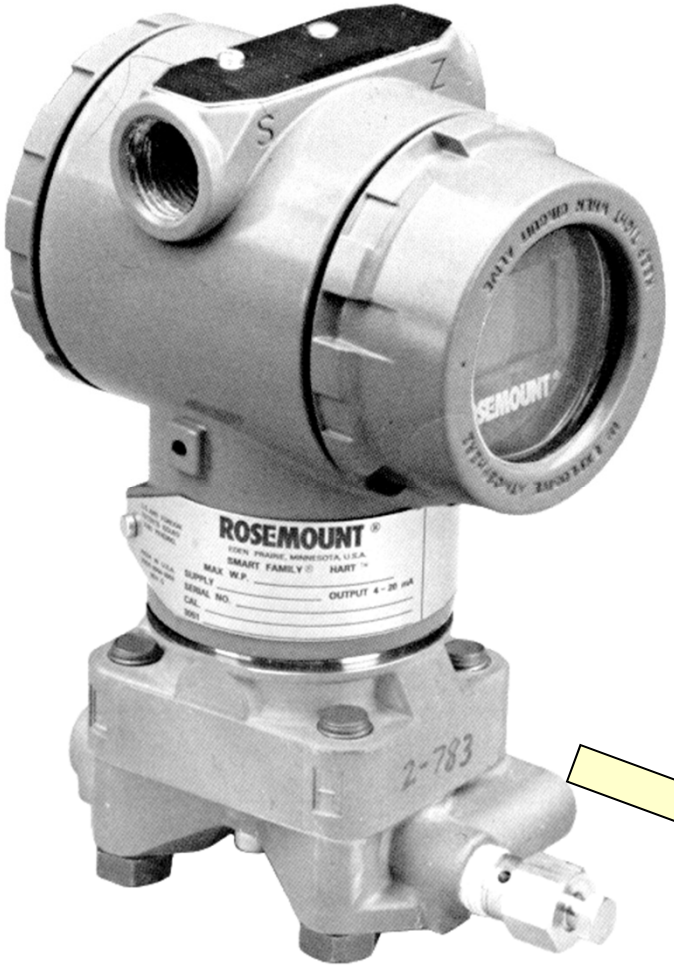
Magne Valen-Sendstad, DNV

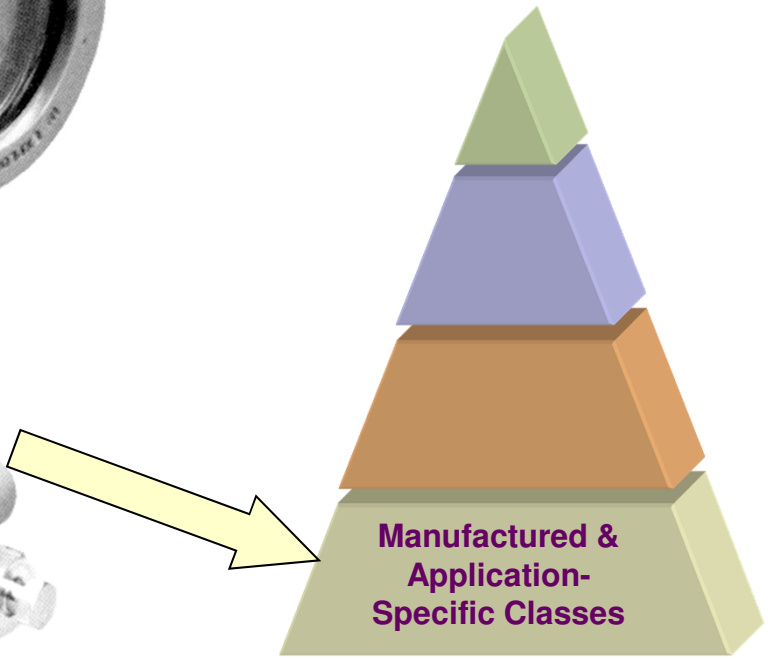
with

Johan W. Klüwer, DNV

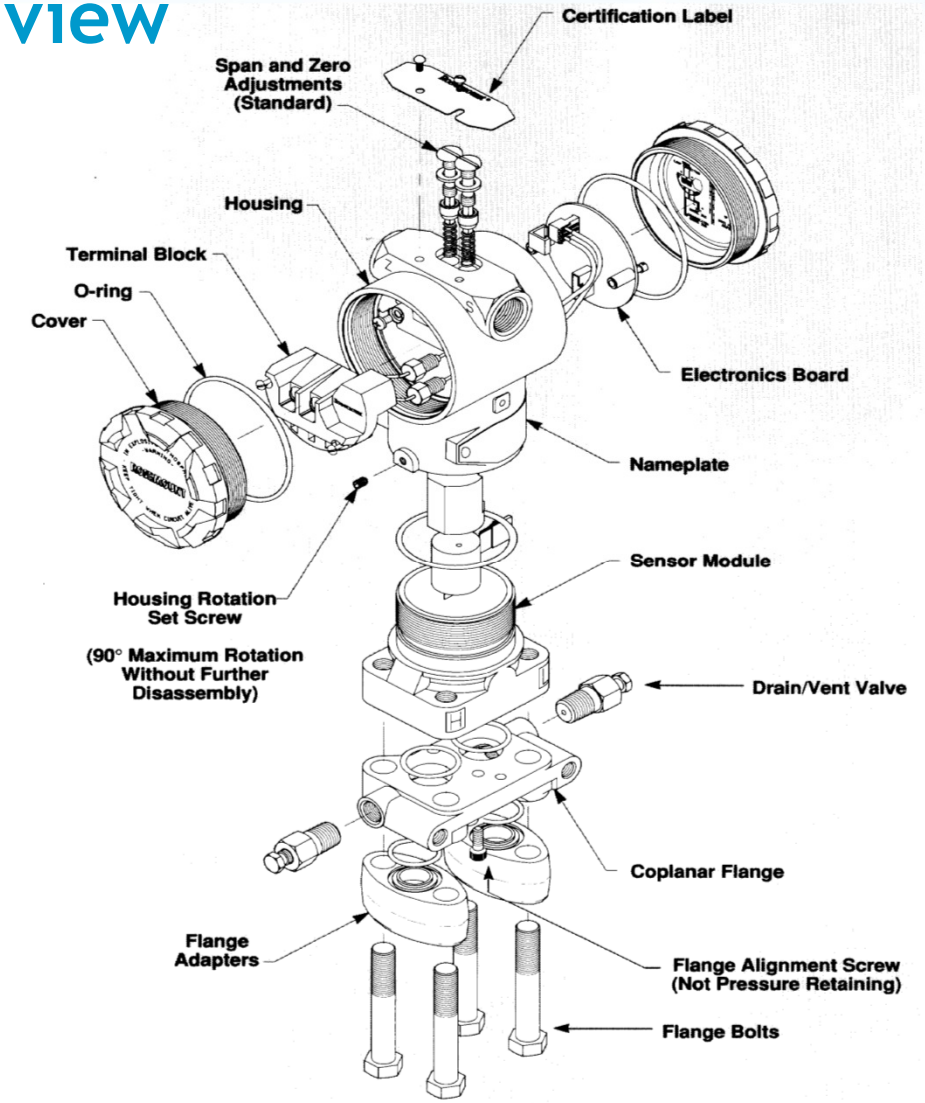
In this session we will use a class of “Electric Pressure Transmitter” as basis for the examples

Rosemount 3051 Gauge Pressure Transmitter





Rosemount 3051 Gauge Pressure Transmitter, exploded view



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Example of multiple representations of the same thing

NORSOK — INSTRUMENT DATASHEET P01

PRESSURE / DIFF. PRESSURE INSTRUMENT ELECTRIC

Tag number	:	Scale Range	:
Service description	:	Set/Alarm Point	:
P&ID	:	Area	:
Line/equipment no.	:	P. O. Number	:

1 GENERAL

1.01 Type	:
1.02 Manufacturer	:
1.03 Manufacturer model no	:
1.04 Operating Temp. Limits	:
1.05 Mounting	:
1.06 Weight	:
1.07 Other	:

2 INSTRUMENT CHARACTERISTICS

2.01 Calibrated input range	:
2.02 Characteristic	:
2.03 Accuracy	:
2.04 Repeatability	:
2.05 Lower / upper range limits	:
2.06 Min / max span	:
2.07 Zero adjustment	:
2.08 Overpressure protect. to	:
2.09 Max static pressure	:
2.10 Other	:

3 ELEMENT / SENSOR

3.01 Type	:
3.02 Material, element (sensor)	:
3.03 Material, socket (inlet port)	:
3.04 Material, sensor bolts/nuts	:
3.05 Process conn. size/type	:
3.06 Sour service spec.	:
3.07 Other	:

4 HOUSING

4.01 Dimension	:
4.02 Material	:
4.03 Cable connection	:
4.04 Cable entry	:
4.05 Enclosure protection	:
4.06 Ex. classification	:
4.07 Protective coating	:
4.08 Other	:

5 TRANSMITTER

5.01 Indicator	:
5.02 Output signal	:
5.03 Communication	:
5.04 Supply voltage	:
5.05 Consumption	:
5.06 Load limitation	:
5.07 Other	:

6 SWITCH

6.01 Reset; automatic or manual	:
6.02 Deadband or differential	:
6.03 Alarm at increase/decrease	:
6.04 Contact configuration	:
6.05 Contact material	:
6.06 Contact rating	:
6.07 Contact action on alarm	:
6.08 Other	:

7 CHEMICAL SEAL

7.01 Type	:
7.02 Material, upper/lower part	:
7.03 Material, bolts / nuts	:
7.04 Material, diaphragm	:
7.05 Fill fluid	:
7.06 Capillary length/diameter	:
7.07 Material, capillary/armour	:
7.08 Process conn. size/type	:
7.09 Other	:

8 ACCESSORIES

8.01 Mounting bracket	:
8.02 Material, mounting bracket	:
8.03 Overpr. protection valve	:
8.04 Material, overpr. prot. valve	:
8.05 Pulsation damper	:
8.06 Material, pulsation damper	:
8.07 Other	:

9 NOTES

Rev	Date	Issue/description	Prepared	Checked	Approved	Datasheet no.	Page

SHARECAT

Datasheet
Transmitter, Pressure, Electric

Document Number	:	28-1A-KOG-I54-27500-0012	Revision	:	1
Plant/Platform	:	Test Installation 2	Process Datash. No.	:	N/A
Tag number	:	PT -42-0304	System	:	N/A
SerialNo	:	N/A	Range From	:	0
SetPoint Low	:	10 barG	Range To	:	110
SetPoint Hight	:	71 barG	Range Unit	:	barG
P & ID	:	28-1A-KOG-C78-00275-0002	Area	:	N/A
Line/Equipment no.	:	XX-42-0002	PO:	:	TI2-M022-ME-01
Service description	:	SCALE INHIBITOR. PUMP OUTLET			

Unique no.	:	TEK-00018117
Manufacturer	:	EMERSON PROCESS MANAGEMENT
Type	:	3051CG
Manuf. Partno.	:	3051CG-5-A-2-2-A-1-K-B4-I1-L4-M6-Q4
Class	:	Transmitter, Pressure, Electric

1. Accepted
2. Accepted with comments incorporated
3. Not accepted, revise and resubmit
4. Issued for information
5. Interface information as clouded is accepted and frozen

Date:	1	2	3	4	5
Sign:					

Area

Explosion protection	:	EEx ia
Gas group	:	IIC
Temperature class	:	T5
Approval authority	:	BASEEFA
Certificate	:	BAS 97ATEX1089X
IP-Class	:	IP66
ATEX group	:	II
ATEX category	:	1
ATEX explosive atmosphere	:	G
Ambient temperature	:	-40 - 85 °C

Dimensions and Weight

Weight	:	4.7 kg

Function

Range	:	0 - 13800 kPa
Span limit minimum, Pressure	:	138 kPa
Span limit maximum, Pressure	:	13800 kPa
Alternative Range	:	0 - 138 bar
Alternative span limit minimum, Pressure	:	1.38 bar
Alternative span limit maximum, Pressure	:	138 bar
Output signal	:	4 - 20 mA
Accuracy	:	+/- 0.075 %
Display type	:	LCD
Static working pressure	:	3626 psi

General

Description	:	Gauge
Description	:	Smart, hart protocol
Supply	:	10.5 - 55 V DC
Mounting	:	Coplanar flange bracket for pipe or panel

Material

Body material	:	Stainless steel
Filling fluid	:	Silicone oil
Seal material	:	Glass filled TFE
Process connection material	:	Stainless steel
Non process cover material	:	316
Flange bolt material	:	316 AUSTENITIC
Drain/vent material	:	Stainless steel
Diaphragm material low pressure connection	:	316L
Diaphragm material high pressure connection	:	316L
Bracket material	:	Stainless steel
Bracket bolt material	:	Stainless steel
Adapter bolt material	:	316 AUSTENITIC

Process Connection

Connection design	:	NPT
Size	:	1/4"
Thread pitch	:	18 thr/in

Supply Connection

Supply connection design	:	Metric threaded
Supply connection size	:	20 mm
Thread pitch supply	:	1.5 mm/thr

Comment

Accuracy for span greater than 10:1 of URL. Power consumption 18-36 mW. Load limitation: 587 Ohm. Static pressure value valid within transmitter temperature spec. Output: Digital signal based on hart protocol. Coplanar flange Intrinsic Safety and Dust approval. Calibration data sheet (5 points calibration at 0%, 25%, 50%, 75%, and 100% of range)

Rev	Date	Issue/description	Prepared	Cheked	Disc. Appr.	Client. Appr.	Page 1 of 1
1	09.11.2006 14:44	Generated by SHARECAT	P.M.				

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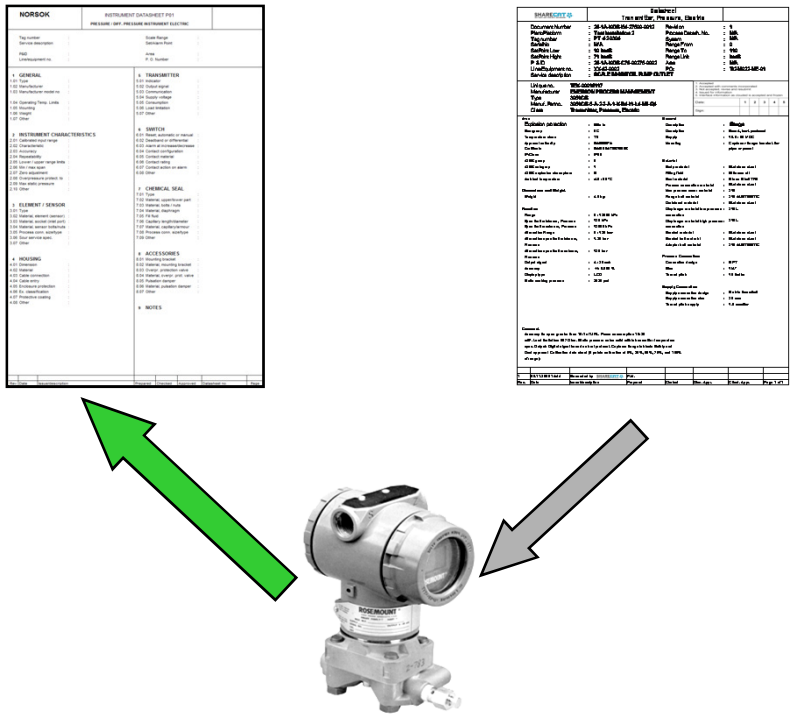
Intelligent Data Sheets Project

- developing neutral product models to support data exchange and integration using "Intelligent Data Sheets" and to
- use these to support new collaborative work processes within and between organizations.
- (companies in the supply chain can save substantially by having one interface to relate to)



Many different, view dependant descriptions
- business
- company
- phase (lifecycle)
- application (DS/2D/3D)
- etc

One neutral, extendable description, supporting multiple views across phases and applications

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Area in focus for this tutorial

NORSOK — INSTRUMENT DATASHEET P01

PRESSURE / DIFF. PRESSURE INSTRUMENT ELECTRIC

Tag number	:	Scale Range	:
Service description	:	Set/Alarm Point	:
P&ID	:	Area	:
Line/equipment no.	:	P. O. Number	:

1 GENERAL

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1.02 Manufacturer	:
1.03 Manufacturer model no	:
1.04 Operating Temp. Limits	:
1.05 Mounting	:
1.06 Weight	:
1.07 Other	:

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2.09 Max static pressure	:
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3.03 Material, socket (inlet port)	:
3.04 Material, sensor bolts/nuts	:
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4.08 Other	:

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5.02 Output signal	:
5.03 Communication	:
5.04 Supply voltage	:
5.05 Consumption	:
5.06 Load limitation	:
5.07 Other	:

6 SWITCH

6.01 Reset; automatic or manual	:
6.02 Deadband or differential	:
6.03 Alarm at increase/decrease	:
6.04 Contact configuration	:
6.05 Contact material	:
6.06 Contact rating	:
6.07 Contact action on alarm	:
6.08 Other	:

7 CHEMICAL SEAL

7.01 Type	:
7.02 Material, upper/lower part	:
7.03 Material, bolts / nuts	:
7.04 Material, diaphragm	:
7.05 Fill fluid	:
7.06 Capillary length/diameter	:
7.07 Material, capillary/armour	:
7.08 Process conn. size/type	:
7.09 Other	:

8 ACCESSORIES

8.01 Mounting bracket	:
8.02 Material, mounting bracket	:
8.03 Overpr. protection valve	:
8.04 Material, overpr. prot. valve	:
8.05 Pulsation damper	:
8.06 Material, pulsation damper	:
8.07 Other	:

9 NOTES

Rev	Date	Issue/description	Prepared	Checked	Approved	Datasheet no.	Page

SHARECAT

Datasheet
Transmitter, Pressure, Electric

Document Number	:	28-1A-KOG-I54-27500-0012	Revision	:	1
Plant/Platform	:	Test Installation 2	Process Datash. No.	:	N/A
Tag number	:	PT -42-0304	System	:	N/A
SerialNo	:	N/A	Range From	:	0
SetPoint Low	:	10 barG	Range To	:	110
SetPoint Hight	:	71 barG	Range Unit	:	barG
P & ID	:	28-1A-KOG-C78-00275-0002	Area	:	N/A
Line/Equipment no.	:	XX-42-0002	PO:	:	TI2-M022-ME-01
Service description	:	SCALE INHIBITOR. PUMP OUTLET			

Unique no.	TEK-00018117	1. Accepted 2. Accepted with comments incorporated 3. Not accepted, revise and resubmit 4. Issued for information 5. Interface information as clouded is accepted and frozen					
Manufacturer	EMERSON PROCESS MANAGEMENT	Date:	1	2	3	4	5
Type	3051CG	Sign:					
Manuf. Partno.	3051CG-5-A-2-2-A-1-K-B4-I1-L4-M6-Q4						
Class	Transmitter, Pressure, Electric						

Area

Explosion protection	:	EEx ia
Gas group	:	IIC
Temperature class	:	T5
Approval authority	:	BASEEFA
Certificate	:	BAS 97ATEX1089X
IP-Class	:	IP66
ATEX group	:	II
ATEX category	:	1
ATEX explosive atmosphere	:	G
Ambient temperature	:	-40 - 85 °C

Dimensions and Weight

Weight	:	4.7 kg

Function

Range	:	0 - 13800 kPa
Span limit minimum, Pressure	:	138 kPa
Span limit maximum, Pressure	:	13800 kPa
Alternative Range	:	0 - 138 bar
Alternative span limit minimum, Pressure	:	1.38 bar
Alternative span limit maximum, Pressure	:	138 bar
Output signal	:	4 - 20 mA
Accuracy	:	+/- 0.075 %
Display type	:	LCD
Static working pressure	:	3626 psi

General

Description	:	Gauge
Description	:	Smart, hart protocol
Supply	:	10.5 - 55 V DC
Mounting	:	Coplanar flange bracket for pipe or panel

Material

Body material	:	Stainless steel
Filling fluid	:	Silicone oil
Seal material	:	Glass filled TFE
Process connection material	:	Stainless steel
Non process cover material	:	316
Flange bolt material	:	316 AUSTENITIC
Drain/vent material	:	Stainless steel
Diaphragm material low pressure connection	:	316L
Diaphragm material high pressure connection	:	316L
Bracket material	:	Stainless steel
Bracket bolt material	:	Stainless steel
Adapter bolt material	:	316 AUSTENITIC

Process Connection

Connection design	:	NPT
Size	:	1/4"
Thread pitch	:	18 thr/in

Supply Connection

Supply connection design	:	Metric threaded
Supply connection size	:	20 mm
Thread pitch supply	:	1.5 mm/thr

Comment

Accuracy for span greater than 10:1 of URL. Power consumption 18-36 mW. Load limitation: 587 Ohm. Static pressure value valid within transmitter temperature spec. Output: Digital signal based on hart protocol. Coplanar flange Intrinsic Safety and Dust approval. Calibration data sheet (5 points calibration at 0%, 25%, 50%, 75%, and 100% of range)

Rev	Date	Issue/description	Prepared	Cheked	Disc. Appr.	Client. Appr.	Page 1 of 1
1	09.11.2006 14:44	Generated by SHARECAT	P.M.				

Uniqueness of Alphanumeric "Attributes"

Area	
Explosion protection	: EEx ia
Gas-group	: IIC
Temperature class	: T5
Approval authority	: BASEEFA
Certificate	: BAS 97ATEX1089X
IP-Class	: IP66
ATEX group	: II
ATEX category	: 1
ATEX explosive atmosphere	: G
Ambient temperature	: -40 - 85 ℃

The remainder of this tutorial will focus on how to map such, and similar "attributes", to ISO15926, and to demonstrate exchange using iRING tools

T5: **Telecinco,**
London Heathrow Terminal 5
Volvo T5 (car or engine?)

T5 here: **T5 APPARATUS IEC 60079-0 (Class of products) (not mentioned by Wikipedia)**

IIC: **International Institute for Conservation of Historic and Artistic Works**

IIC here: **GROUP IIC APPARATUS IEC 60079-0 (Class of products)**

IP66: **IP66 APPARATUS IEC 60529 (Class of products)**

EEx ia: **EX IA APPARATUS IEC 60079-11 (Class of products)**

A range on the data sheet

SHARECAT
ANY PART. ANY PROJECT. ANYWHERE.

Datasheet
Transmitter, Pressure, Electric

Document Number	:	**28-1A-KOG-I54-27500-0012**	Revision	:	**1**
Plant/Platform	:	**Test Installation 2**	Process Datash. No.	:	**N/A**
Tag number	:	**PT -42-0304**	System	:	**N/A**
SerialNo	:	**N/A**	Range From	:	**0**
SetPoint Low	:	**10 barG**	Range To	:	**110**
SetPoint Hight	:	**71 barG**	Range Unit	:	**barG**
P & ID	:	**28-1A-KOG-C78-00275-0002**	Area	:	**N/A**
Line/Equipment no.	:	**XX-42-0002**	PO:	:	**TI2-M022-ME-01**
Service description	:	**SCALE INHIBITOR. PUMP OUTLET**			

Unique no.	**TEK-00018117**
Manufacturer	**EMERSON PROCESS MANAGEMENT**
Type	**3051CG**
Manuf. Partno.	**3051CG-5-A-2-2-A-1-K-B4-I1-**
Class	**Transmitter, Pressure, Electr**

1. Accepted
2. Accepted with comments incorporated
3. Not accepted, revise and resubmit
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Area

Explosion protection	:	**EEx ia**
Gas-group	:	**IIC**
Temperature class	:	**T5**
Approval authority	:	**BASEEFA**
Certificate	:	**BAS 97ATEX1089X**
IP-Class	:	**IP66**
ATEX group	:	**II**
ATEX category	:	**1**
ATEX explosive atmosphere	:	**G**
Ambient temperature	:	**-40 - 85 °C**

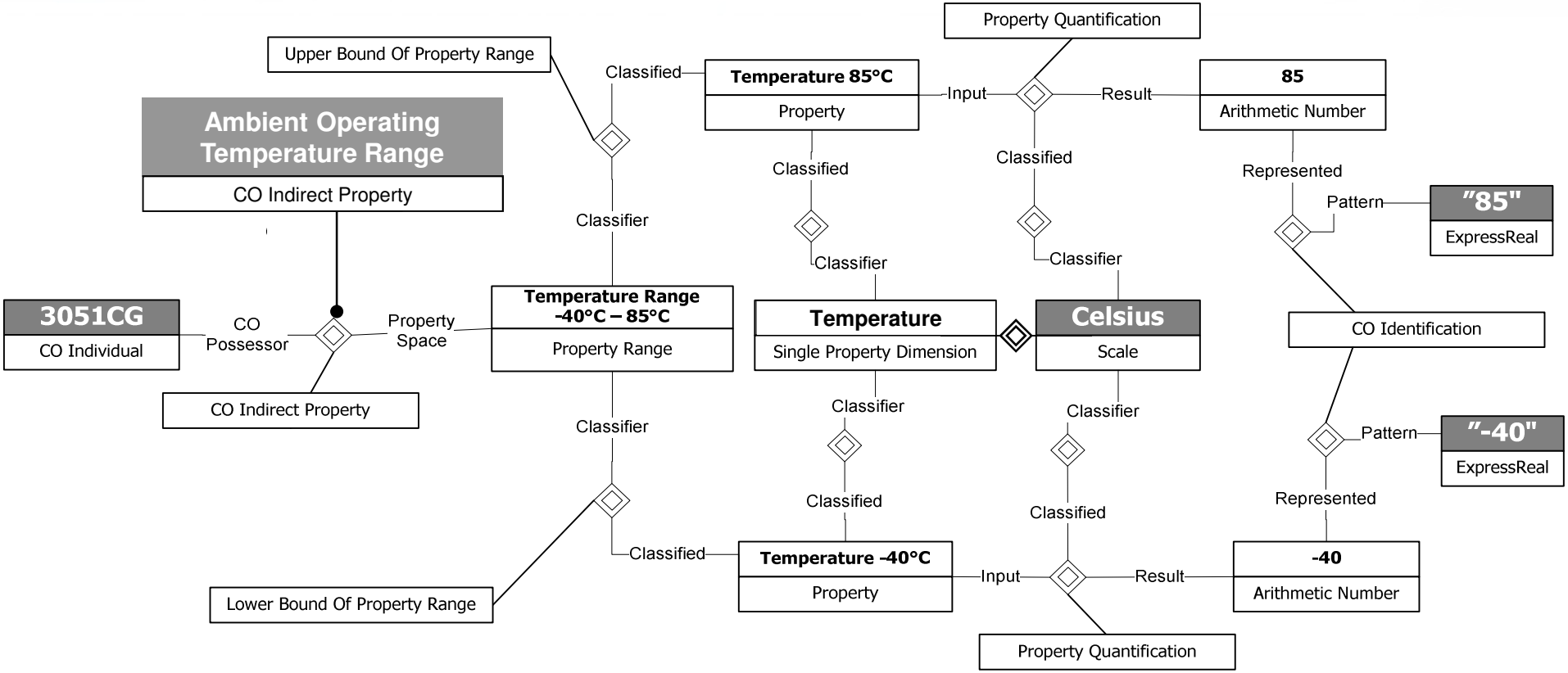
Dimensions and Weight

Weight	:	**4.7 kg**

Filling fluid	:	**Silicone oil**
Seal material	:	**Glass filled TFE**
Process connection material	:	**Stainless steel**
Non process cover material	:	**316**
Flange bolt material	:	**316 AUSTENITIC**
Drain/vent material	:	**Stainless steel**

ATEX group	:	**II**
ATEX category	:	**1**
ATEX explosive atmosphere	:	**G**
Ambient temperature	:	**-40 - 85 °C**

Representation of “attribute”: Ambient Temperature



3051CG has a ”rated ambient operating temperature”: -40 C – 85 C

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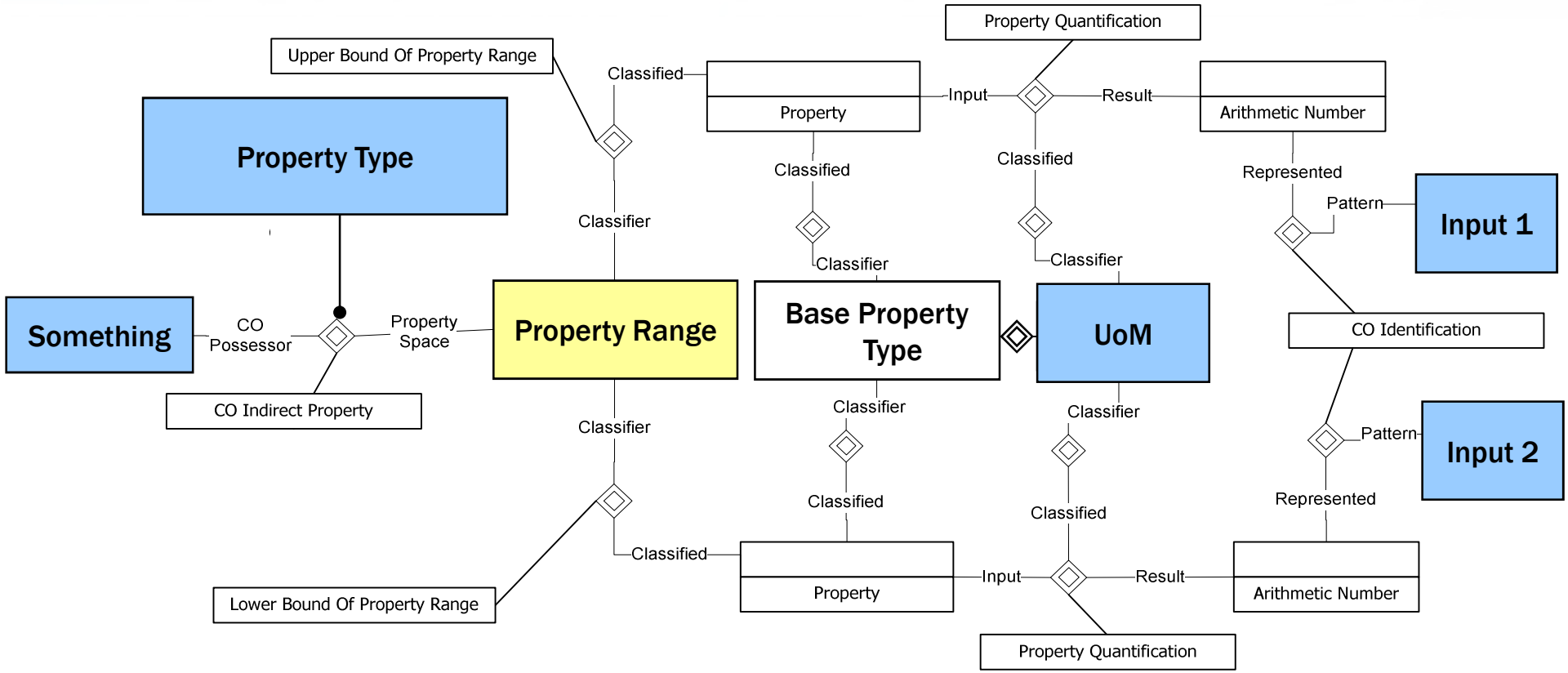
ISO 15926 Generic Property Range Template



'Something' has 'Property Type' with 'Property Range' of 'Base Property Type' defined by 'Input 1' and 'Input 2' with 'UoM'

"Semantic" Mapping User Interface

Select RDL Class or Project Data

Select from standard/ customised list of RDL Instance

Select from standard/ customised list of RDL Instance

Temp. Inst. #	Something	Property Type	UoM	Input 1	Input 2
#nnn	3051CG	Ambient Operating Temperature Range	C	-40	85

Property Range

Base Property Type

Implicit entities that only appear in the "full" model

Approach is applicable to any external data representation.

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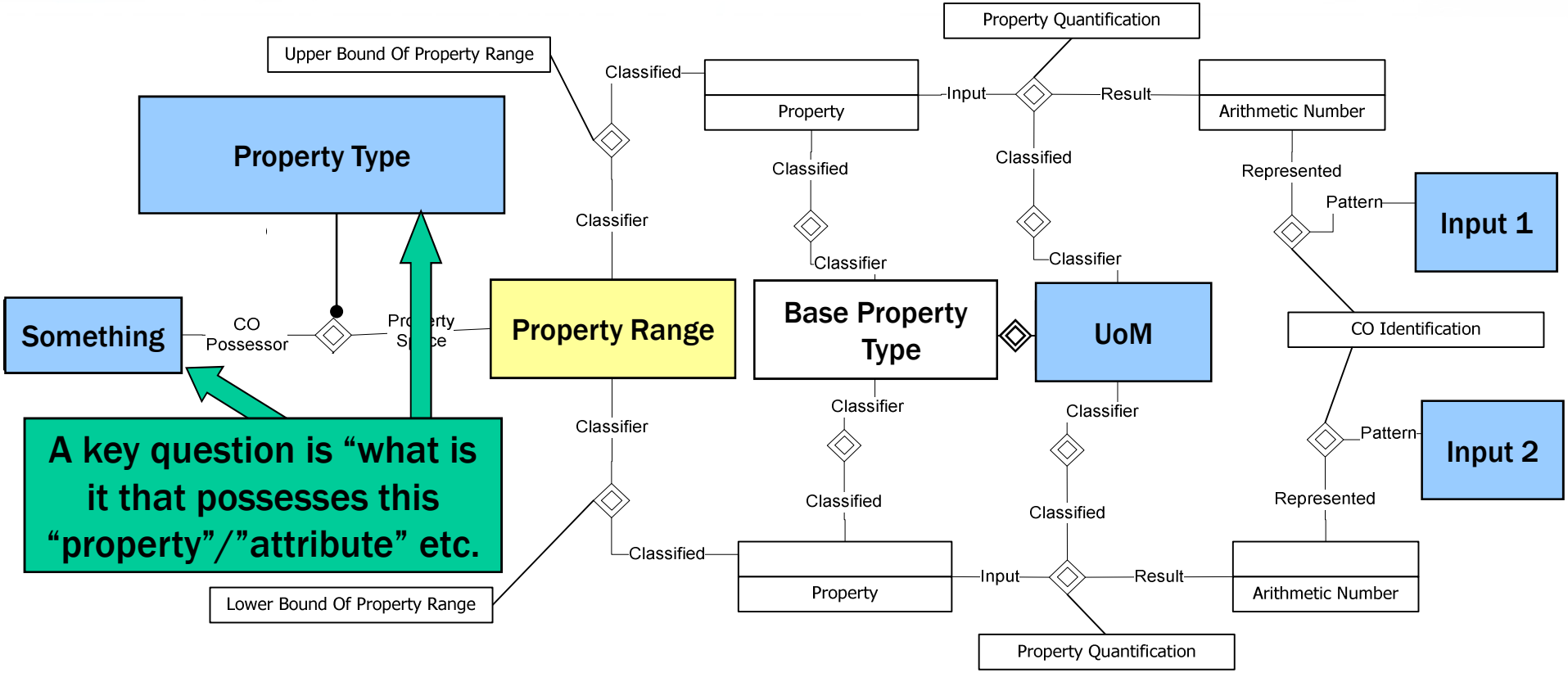
ISO 15926 Generic Property Range Template



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Unrelated data related to the same thing

NORSOK

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9 NOTES

Rev	Date	Issue/description	Prepared	Checked	Approved	Datasheet no.	Page

SHARECAT

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Transmitter, Pressure, Electric

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Type	3051CG
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Process Connection

Connection design	:	NPT
Size	:	1/4"
Thread pitch	:	18 thr/in

Supply Connection

Supply connection design	:	Metric threaded
Supply connection size	:	20 mm
Thread pitch supply	:	1.5 mm/thr

Comment

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1	09.11.2006 14:44	Generated by SHARECAT	P.M.				

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Inconsistent Representations

NORSOK

INSTRUMENT DATASHEET P01

PRESSURE / DIFF. PRESSURE INSTRUMENT ELECTRIC

Tag number :
Service description :
P&ID :
Line/equipment no. :
Scale Range :
Set/Alarm Point :
Area :
P. O. Number :

1 GENERAL
1.01 Type :
1.02 Manufacturer :
1.03 Manufacturer model no :
1.04 Operating Temp. Limits :
1.05 Mounting :
1.06 Weight :
1.07 Other :

2 INSTRUMENT CHARACTERISTICS
2.01 Calibrated input range :
2.02 Characteristic :
2.03 Accuracy :
2.04 Repeatability :
2.05 Lower / upper range limits :
2.06 Min / max span :
2.07 Zero adjustment :
2.08 Overpressure protect. to :
2.09 Max static pressure :
2.10 Other :

3 ELEMENT / SENSOR
3.01 Type :
3.02 Material, element (sensor) :
3.03 Material, socket (inlet port) :
3.04 Material, sensor bolts/nuts :
3.05 Process conn. size/type :
3.06 Bolt service spec. :
3.07 Other :

4 HOUSING
4.01 Dimension :
4.02 Material :
4.03 Cable connection :
4.04 Cable entry :
4.05 Enclosure protection :
4.06 Ex. classification :
4.07 Protective coating :
4.08 Other :

5 TRANSMITTER
5.01 Indicator :
5.02 Output signal :
5.03 Communication :
5.04 Supply voltage :
5.05 Consumption :
5.06 Load limitation :
5.07 Other :

6 SWITCH
6.01 Reset; automatic or manual :
6.02 Deadband or differential :
6.03 Alarm at increase/decrease :
6.04 Contact configuration :
6.05 Contact material :
6.06 Contact rating :
6.07 Contact action on alarm :
6.08 Other :

7 CHEMICAL SEAL
7.01 Type :
7.02 Material, upper/lower part :
7.03 Material, bolts / nuts :
7.04 Material, diaphragm :
7.05 Fill fluid :
7.06 Capillary length/diameter :
7.07 Material, capillary/armour :
7.08 Process conn. size/type :
7.09 Other :

8 ACCESSORIES
8.01 Mounting bracket :
8.02 Material, mounting bracket :
8.03 Overpr. protection valve :
8.04 Material, overpr. prot. valve :
8.05 Pulsation damper :
8.06 Material, pulsation damper :
8.07 Other :

Rev	Date	Issue/description	Prepared	Checked	Approved	Datasheet no.	Page

Representation 1, Context 1

SHARECAT

Datasheet
Transmitter, Pressure, Electric

Document Number	: 28-1A-KOG-I54-27500-0012		Revision	: 1
Plant/Platform	: Test Installation 2		Process Datash. No.	: N/A
Tag number	: PT -42-0304		System	: N/A
SerialNo	: N/A		Range From	: 0
SetPoint Low	: 10 barG		Range To	: 110
SetPoint Hight	: 71 barG		Range Unit	: barG
P & ID	: 28-1A-KOG-C78-00275-0002		Area	: N/A
Line/Equipment no.	: XX-42-0002		PO:	: TI2-M022-ME-01
Service description	: SCALE INHIBITOR. PUMP OUTLET			

Unique no.	TEK-00018117
Manufacturer	EMERSON PROCESS MANAGEMENT
Type	3051CG
Manuf. Partno.	3051CG-5-A-2-2-A-1-K-B4-I1-L4-M6-Q4
Class	Transmitter, Pressure, Electric

1. Accepted
2. Accepted with comments incorporated
3. Not accepted, revise and resubmit
4. Issued for information
5. Interface information as clouded is accepted and frozen

Date:	1	2	3	4	5
Sign:					

Area

Explosion protection	: EEx ia
Gas-group	: IIC
Temperature class	: T5
Approval authority	: BASEEFA
Certificate	: BAS 97ATEX1089X
IP-Class	: IP66
ATEX group	: II
ATEX category	: 1
ATEX explosive atmosphere	: G
Ambient temperature	: -40 - 85 °C

Dimensions and Weight

Weight	: 4.7 kg

Function

Range	: 0 - 13800 kPa
Span limit minimum, Pressure	: 138 kPa
Span limit maximum, Pressure	: 13800 kPa
Alternative Range	: 0 - 138 bar
Alternative span limit minimum, Pressure	: 1.38 bar
Alternative span limit maximum, Pressure	: 138 bar
Output signal	: 4 - 20 mA
Accuracy	: +/- 0.075 %
Display type	: LCD
Static working pressure	: 3626 psi

General

Description	: Gauge
Description	: Smart, hart protocol
Supply	: 10.5 - 55 V DC
Mounting	: Coplanar flange bracket for pipe or panel

Material

Body material	: Stainless steel
Filling fluid	: Silicone oil
Seal material	: Glass filled TFE
Process connection material	: Stainless steel
Non process cover material	: 316
Flange bolt material	: 316 AUSTENITIC
Drain/vent material	: Stainless steel
Diaphragm material low pressure connection	: 316L
Diaphragm material high pressure connection	: 316L
Bracket material	: Stainless steel
Bracket bolt material	: Stainless steel
Adapter bolt material	: 316 AUSTENITIC

Process Connection

Connection design	: NPT
Size	: 1/4"
Thread pitch	: 18 thr/in

Supply Connection

Supply connection design	: Metric threaded
ize	: 20 mm
	: 1.5 mm/thr

Representation 2, Context 2

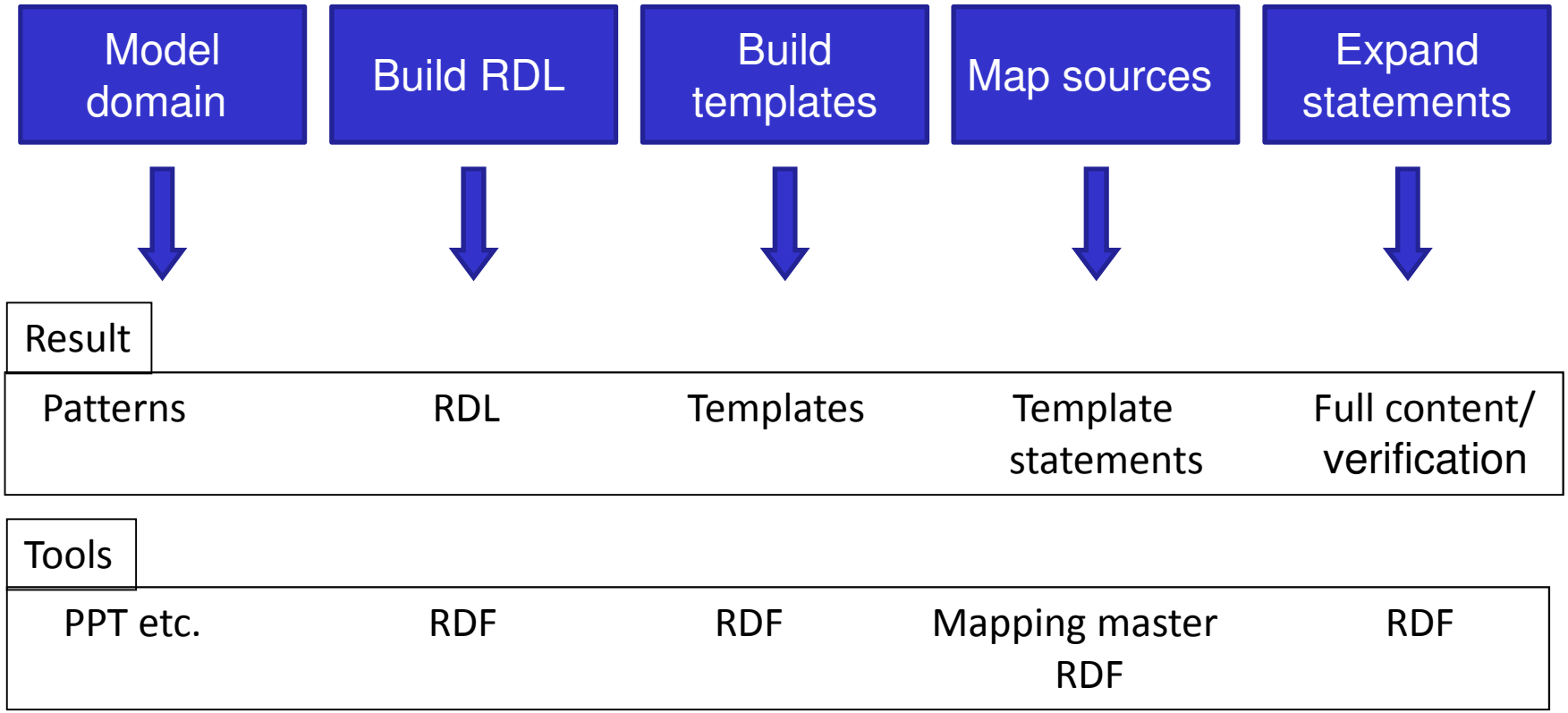
Comment

tion 18-36
thin transmitter temperature
flange Intrinsic Safety and
0%, 25%, 50%, 75%, and 100%

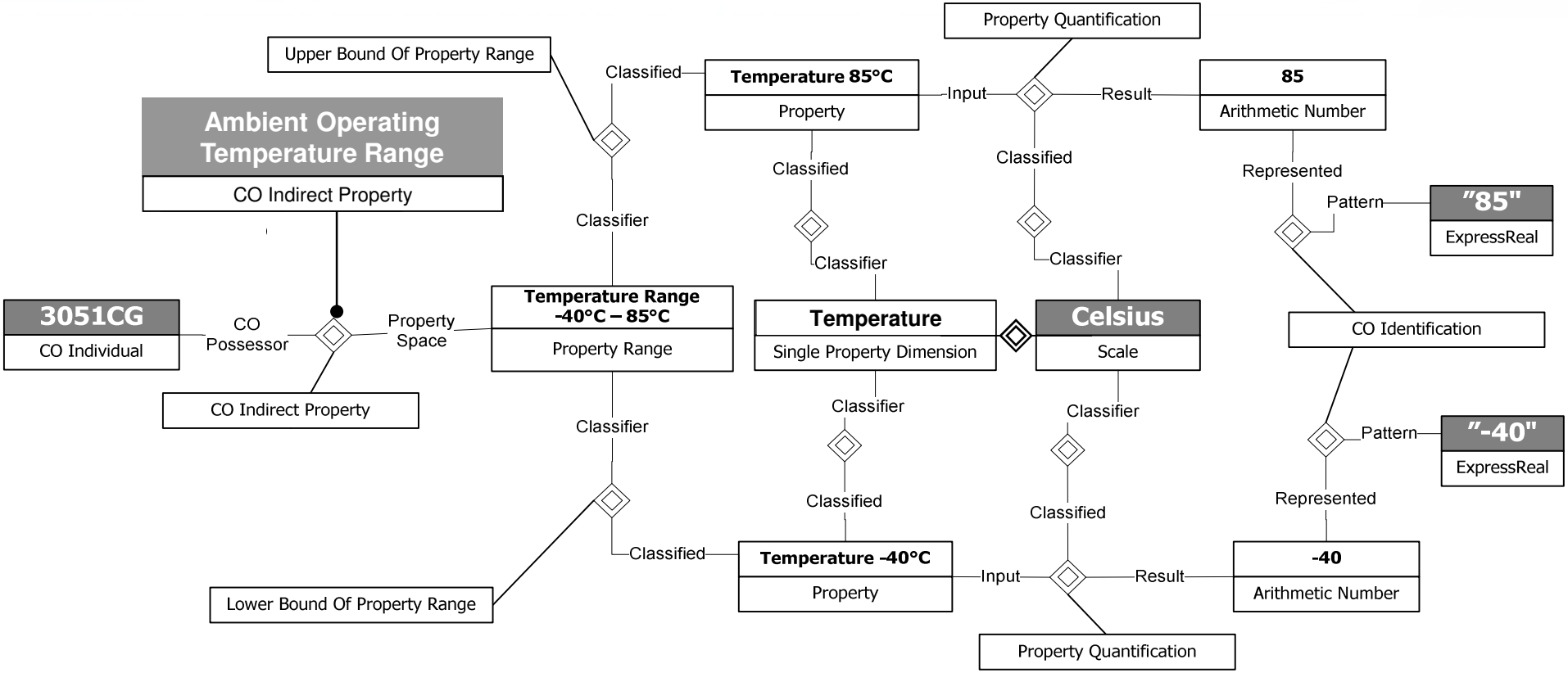
ANSI/ASME B1.20.1 1/4 - 18 NPT-F

Rev.	Date	Issue/description	Prepared	Cheked	Disc. Appr.	Client. Appr.	Page 1 of 1
1	09.11.2006 14:44	Generated by SHARECAT	P.M.				

Process description



Model domain: Ambient Temperature Range

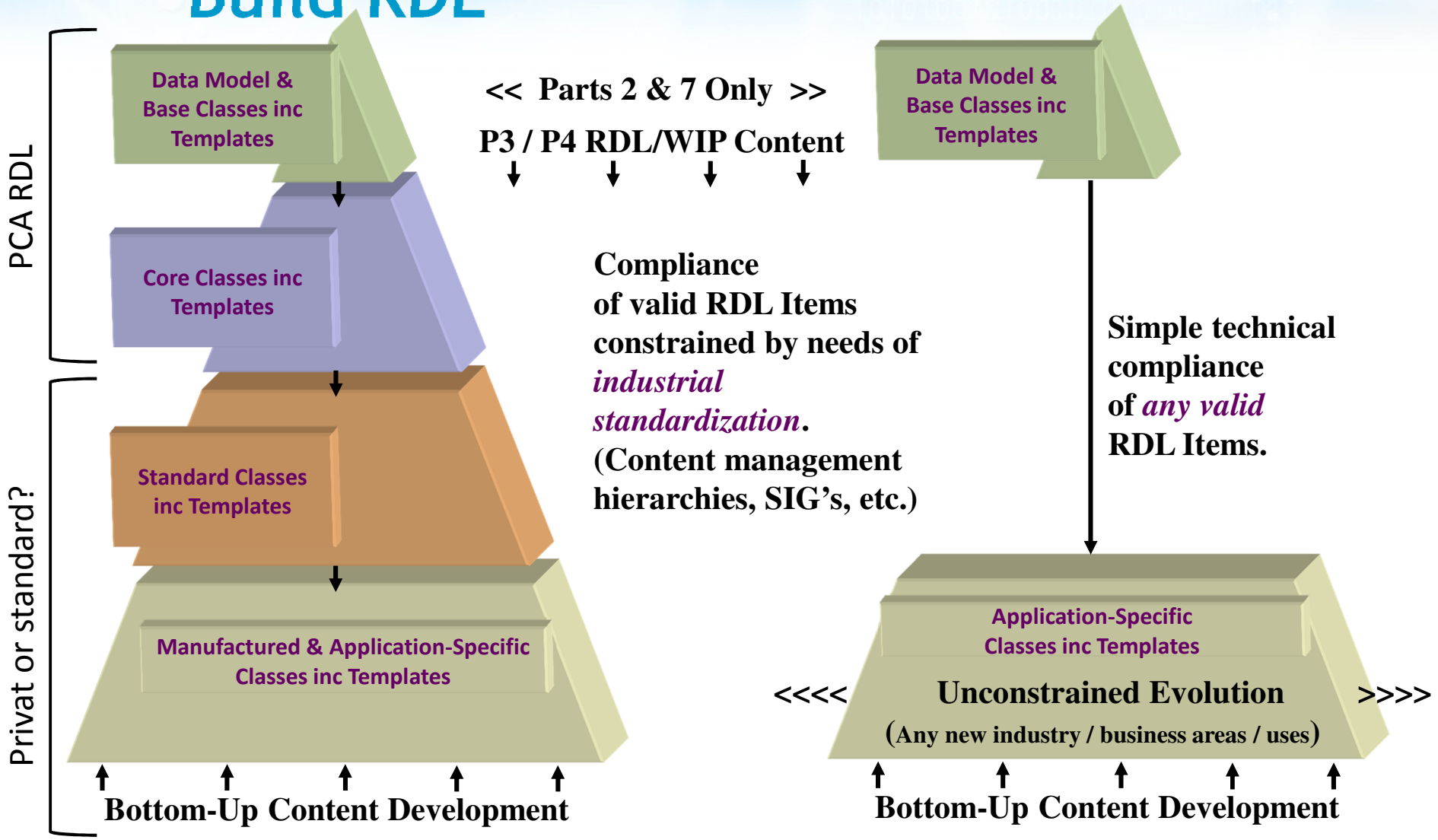


3051CG has a "ambient operating temperature": -40 C – 85 C

POSC Caesar Association

www.posccaesar.com

Build RDL



Build templates

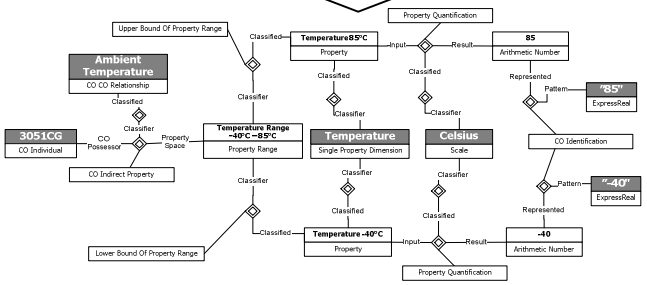
Template signature

Template instance (fact)

Temp. Inst. #	Something	Property Type	UoM	Input 1	Input 2
#jjj	3051CD	AMBIENT OPERATING TEMPERATURE RANGE	C	-40	85
#jjj	3051CD	AMBIENT OPERATING TEMPERATURE RANGE	C	-40	85
#kkk	2051TG	AMBIENT STORAGE TEMPERATURE RANGE	C	-46	110

Template axiom

```
PropertyRangeMagnitudeRestrictionOfClass(x1, x2, x3, x4, x5) <->
  ClassOfIndividual(x1) &
  ClassOfIndirectProperty(x2) &
  Scale(x3) &
  ExpressReal(x4) &
  ExpressReal(x5) &
  exists u (PropertyRangeRestrictionOfClass(x1, x2, u) &
   exists y1 exists y2 (
    IdentificationByNumber(x4, y1) &
    IdentificationByNumber(x5, y2) &
    LowerUpperMagnitudeOfPropertyRange(u, x3, y1, y2))) .
```



Mapping is a multi-stage process

- **What is to be represented**
  - Format
    1. From a particular format determine which template signatures and classes to use to represent the types of statements represented by each label
       - This involves amongst other inspecting the source to identify the “implicit” object types
       - Identify shortcuts one might want to use to avoid representation “overkill”
    2. For potential new template signatures, define its corresponding expansion to full Part 2/3/4 representation.
    3. Which options are involved for types of objects represented using the format?
  - Content
    - To define the actual relationships that a particular “object” represented using a datasheet format involves, e.g. which particular relationships applies for “3051CG-5-A-2-2-A-1-K-I1-M6”

- **How to implement**
  1. Template signatures for data exchange or “format compliant” storage
  2. Full expansion to Part 2/4/RDL compliant data store

  (Need this also for 1. for verification)