

Designed for Safety, Security, and Reliability

Open Data Schema

For Process Safety Applications

Proprietary Closed Software is the Norm

- While good for legacy vendors, causes many problems for operating companies – disruptive change is coming
 - Desktop software limits team access / can't be required to connect to internet
 - Sharing data with customer teams (Operator, EPC, MAC, Consultants)
 - Transfer of data to other applications not possible, re-entry of the same data multiple times
 - Comparison/benchmarking impossible due to inconsistent data structure
 - Data is held hostage (less features, increasing cost)
 - Revision tracking / management of change is challenging (ask me about GitHub)



Traditional Desktop – Proprietary Binary Data

- Data format is specific to application, often customizable
- Reverse engineering is illegal!

| Deviation | Cause | Consequence | Safeguards |
|---------------|------------------------|---|-------------|
| Less Flow | Valve fails closed | No consequence | None |
| More Flow | Valve fails open | Pipe erosion with potential loss of containment | None |
| Reverse Flow | Improper valve line up | Product contamination | Check Valve |
| Less Pressure | Valve fails open | No consequence | None |
| More Pressure | Valve fails closed | Overpressure and loss of containment | PSV |

```

1 %PDF-1.6
2 %aãIó
3 482 0 obj
4 <</Linearized 1/L 105372/O 484/E 49230/N 3/T 104831/H [ .
5 endobj
6
7 503 0 obj
8 <</DecodeParms<</Columns 4/Predictor 12>>/Filter/FlateDe
9 hÞbbdDIE`b`ÉACKDC2E«AD9`ØFTX#CANà,ŽB Á`ACKH°ú`« çDC3#7
10 2" `šÅACK#STINULSOHACKNULóSO?
11 endstream
12 endobj
13 startxref
14 0
15 %%EOF
16
17 521 0 obj
18 <</C 674/Filter/FlateDecode/I 696/Length 560/S 254/V 539:
19 hÞb` ``f` `sIÀÈÀ +Ã À«NULSTXCFIERSIE,ERS
20 lóDCANCAN8Q...+~À%...EDY`SUB5UUÓ`4tµm--~il`RSIFTX}}ü,STXBf`DC
21 óDC4óÖtIIM
22 \YLæ-ÝRS*#=#] "£Ã<Äý£Bbáb"R3%ÅÅdDC2ÓóÓENO"ENOYád3*sryÜjES
23 VIEŠ«+ÈKø32ENOFOIÖw40 FTX#SO<NUL`ÜFTX#E#øBS(ÅÅÅÈXACKòDI
24 BET*ESC*10CAN[ °iNULq%SI7,`Åxf) f=A,,A¶Á!USÈ]ÁÈÀ6×A*Å,,!`á
25 endstream
26 endobj
27 483 0 obj
28 <</AcroForm 504 0 R/Lang (þýNULNULNUL-NULUNULS)/MarkIn
29 endobj

```

Traditional Client-Server SQL

| ID | Node | Description |
|----|------|--------------------|
| 1 | 1 | Inlet Separator |
| 2 | 2 | Separator Pump |
| 3 | 1 | Distillation |
| 4 | 2 | Valve fails open |
| 5 | 3 | Valve fails closed |

- Very slow – database transactions one record at a time
- Poor scalability / no separation
- Complex - Data abstraction further delay
- Online/offline synchronization / Versioning
- Structure still proprietary!

| ID | Node ID | Deviation |
|----|---------|--------------|
| 1 | 1 | High Flow |
| 2 | 1 | Low Flow |
| 3 | 2 | Reverse Flow |

| ID | Deviation ID | Cause |
|----|--------------|---|
| 1 | 1 | Operator inadvertently starts spare pump |
| 2 | 1 | Flow control valve fails to the open position |
| 3 | 2 | Charge pump stops |
| 4 | 2 | Inadvertent valve closure |
| 5 | 2 | Flow control valve fails to the closed position |

I ❤️ JSON

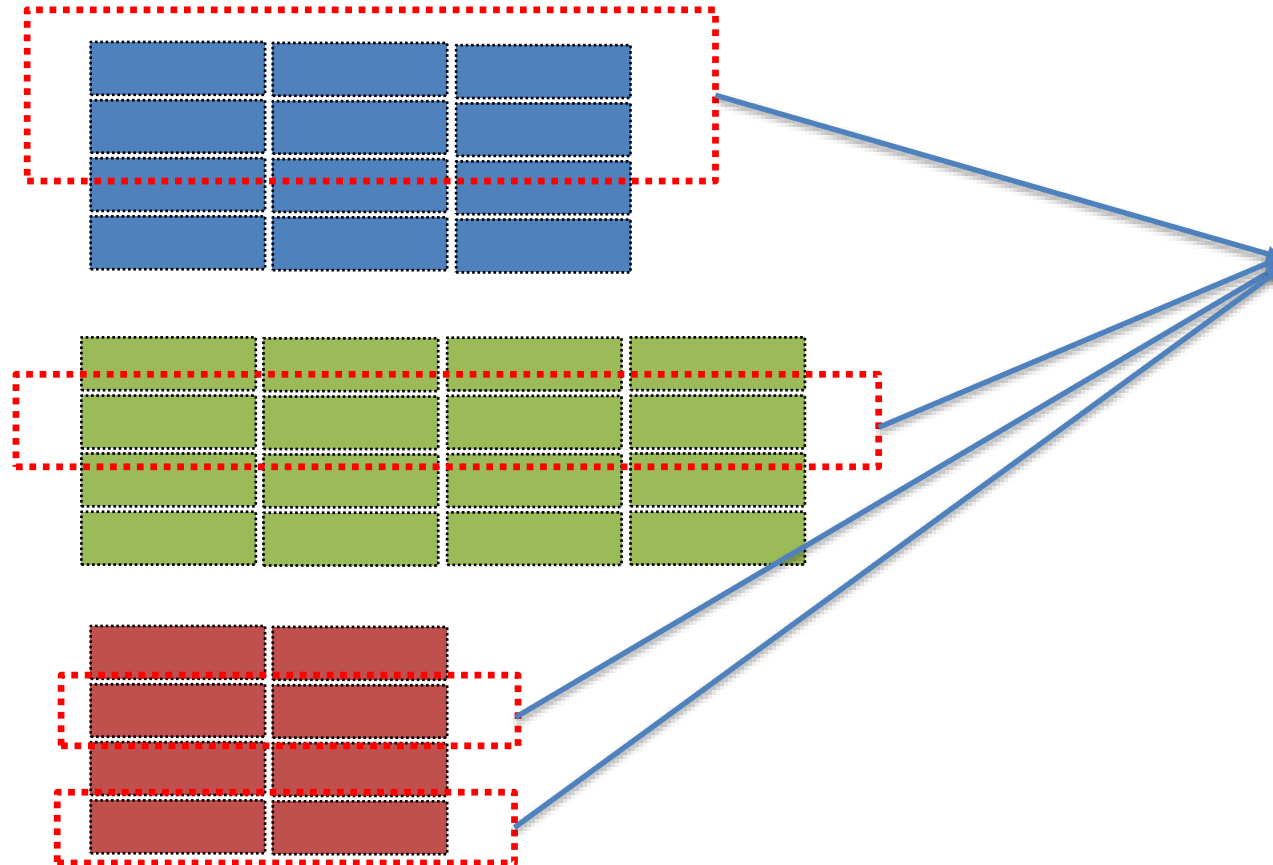
- JavaScript Object Notation
- Most prominent data storage/transfer mechanism of the “new” web
- Self documenting
- Text-based, flexible
- Similar to XML but lighter
- Document Databases – collections of JSON objects are replacing traditional SQL databases
- Ubiquitous – any language or op system

Heat and Weight Balance Stream as JSON

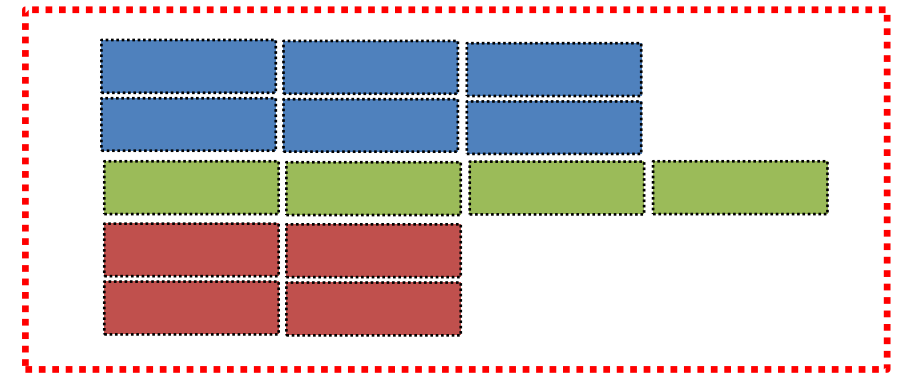
```
<> Read JSON.html • {} stream.json ✕
1  {
2    "streamName": "001",
3    "temperature": "273",
4    "temperatureUnits": "F",
5    "pressure": "450",
6    "pressureUnits": "psig",
7    "components": [
8      {"componentName": "methane", "massFlow": "345.3", "massFlowUnits": "lbs/hr"},
9      {"componentName": "ethane", "massFlow": "45.3", "massFlowUnits": "lbs/hr"},
10     {"componentName": "propane", "massFlow": "2.34", "massFlowUnits": "lbs/hr"}
11   ]
12 }
```

SQL Data Serialized to JSON

SQL Database Tables



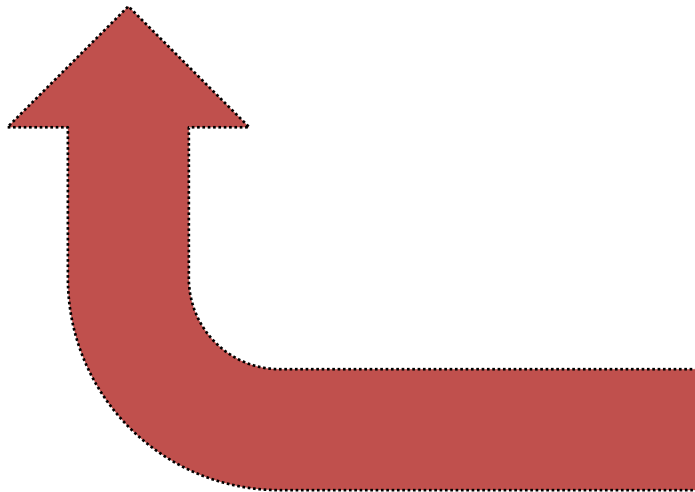
JSON Object



JSON Schema

- Define the expected data and types of a JSON object

```
Read JSON.html • stream.json ×
1 {
2   "streamName": "001",
3   "temperature": "273",
4   "temperatureUnits": "F",
5   "pressure": "450",
6   "pressureUnits": "psig",
7   "components": [
8     {"componentName": "methane", "massFlow": "345.3", "massFlowUnits": "lbs/hr"},
9     {"componentName": "ethane", "massFlow": "45.3", "massFlowUnits": "lbs/hr"},
10    {"componentName": "propane", "massFlow": "2.34", "massFlowUnits": "lbs/hr"}
11  ]
12 }
```



```
1 {
2   "$id": "http://example.com/example.json",
3   "type": "object",
4   "definitions": {},
5   "$schema": "http://json-schema.org/draft-07/schema#",
6   "properties": {
7     "streamName": {
8       "$id": "/properties/streamName",
9       "type": "string",
10      "title": "The Streamname Schema ",
11      "default": "",
12      "examples": [
13        "001"
14      ]
15    },
16    "temperature": {
17      "$id": "/properties/temperature",
18      "type": "string",
19      "title": "The Temperature Schema ",
20      "default": "",
21      "examples": [
22        "273"
23      ]
24    },
25    "temperatureUnits": {
26      "$id": "/properties/temperatureUnits",
27      "type": "string",
28      "title": "The Temperatureunits Schema ",
29      "default": "",
30      "examples": [
31        "F"
32      ]
33    },
34  },
35 }
```


If we can't agree – Customizable “Super-Set”

Consequences

- Consequence
- Likelihood Before Safeguards
- Risk Ranking Before Safeguards
- Likelihood
- Risk Ranking
- LOPA Required
- PHA Recommendations
- PHA Comments
- Lopa Recommendations
- Lopa Comments
- Consequence Category
- Consequence Severity Before Safeguards
- Consequence Severity
- Conditional Modifiers

| Deviation | Cause | Consequence | CAT | S | L | RR | S | L | RR |
|-------------------|--|---|-----|-------------------|-------------------|-------------------|-----|-----|----|
| | | | | Before Safeguards | Before Safeguards | Before Safeguards | | | |
| 1.1 High Pressure | 1.1.1 Outlet pressure control valve fails to the closed position | 1.1.1.1 Increase in drum pressure up to the dead head pressure of the pump. This pressure is 150% of the MAWP of the vessel, and as such damage to connections and appurtenance to the vessel are expected to fail, causing loss of containment with the potential for toxic chemical exposure, and if ignited exposure to fire and/or explosion. Due to occupancy, | S ▼ | ▼ | ▼ | | H ▼ | M ▼ | 3 |

Consequences

- Consequence
- Likelihood Before Safeguards
- Risk Ranking Before Safeguards
- Likelihood
- Risk Ranking
- LOPA Required
- PHA Recommendations
- PHA Comments
- Lopa Recommendations
- Lopa Comments
- Consequence Category
- Consequence Severity Before Safeguards
- Consequence Severity
- Conditional Modifiers

| Deviation | Cause | Consequence | CAT | S | L | RR |
|-------------------|--|---|-----|-----|-----|----|
| | | | | | | |
| 1.1 High Pressure | 1.1.1 Outlet pressure control valve fails to the closed position | 1.1.1.1 Increase in drum pressure up to the dead head pressure of the pump. This pressure is 150% of the MAWP of the vessel, and as such damage to connections and appurtenance to the vessel are expected to fail, causing loss of containment with the potential for toxic chemical exposure, and if ignited exposure to fire and/or explosion. Due to occupancy, | S ▼ | H ▼ | M ▼ | 3 |

Implications of Standard JSON Schema

- Some Software becomes GUI for JSON objects
- Some Software becomes “methods” for JSON object creation or transformation

Overview

Study Name

Study Coordinator

Study Coordinator Contact Info

Facility

Facility Location

Facility Owner

Unit

Project Number

Report Number

Project Description

```
Quantum.html  {} Chemical Properties.json  {} stream 001.json  {} Demo.json x  🔍
1  {"Overview":
2    {"Study_Name":"General Oil and Gas Chemical Company Bayou City Plant",
   "Study_Coordinator":"Edward M. Marszal",
   "Study_Coordinator_Contact_Info":"edward.marszal@kenexis.com",
   "Facility":"Bayou City Plant",
3   "Facility_Location":"Bayou City Texas",
4   "Facility_Owner":"","
5   "Unit":"","
6   "Project_Number":"","
7   "Report_Number":"","
8   "Project_Description":"","
9   "General_Notes":""},
10  "Settings":{
11    "Ds_Rev":5,
```

Potential Applications

- Process simulators create stream data objects to pass to consequence analysis software
- Consequence analysis software creates dispersion model objects to pass to gas detection mapping software
- HAZOP software creates safety instrumented function objects to pass to SIL verification software
- SIL verification software creates design data to pass to engineering station software that automatically programs PLCs

- ** Currently, JSON schema are being used to pass data between Kenexis Effigy fire and gas mapping software and Sandia's CHAMA optimization tool

Share data among technical safety tasks

- LOPA Independent Protection Layers can become Safety Instrumented Functions with a few clicks

The screenshot shows a table with the following data:

| IPL | IPL Tag | PFD | IPL Type | Reference |
|--|----------|------|--------------|-----------|
| 1 Relief Valve on High Pressure Separator | PSV-101 | 0.01 | Relief Valve | 1.1.1.1 |
| 2 High Pressure Separator (V-101) High-High Pressure | UZC-101A | 0.1 | SIF | 1.1.1.1 |

Below the table is a dialog box titled "Synchronize [redacted] IPL's with Vertigo IPF's". It contains radio buttons for "Create New [redacted] Study" and "Update Existing [redacted] Study". There is a text input field for "Study Name" containing "New [redacted] Study" and a list box for "IPL Type Filters" containing "SIF". Buttons for "Synchronize" and "Cancel" are at the bottom.

The screenshot shows a web browser window with the URL "https://[redacted]ipfs.aspx". The page title is "Texas City SIS". The navigation bar includes tabs for "IPF List", "SIL Verification Summary", "Events", and "Revisions". Below the navigation bar is a table with the following data:

| Tag | IPF Description | IPF Type | Selected SIL | Sensors Tag | Voting |
|----------|--|----------|--------------|-------------|--------|
| UZC-101A | <u>High Pressure Separator (V-101) High-High Pressure Closes Inlet Valve</u> | SIF | SIL 1 | | |
| UZC-101B | <u>High Pressure Separator (V-101) Low-Low Level Closes Outlet Valve</u> | SIF | SIL 2 | | |
| UZC-101C | <u>High Pressure Separator (V-101) High-High Level Closes Inlet Valve</u> | SIF | SIL 1 | | |

Consider a system where dispersion model footprints overlaid on satellite photos are viewed from the HAZOP software with one click

Current MS Project

- Develop a Schema for HAZOP-style PHA
 - Survey industry to determine all of the “fields” employed for PHA
 - Please assist our MS Student!!
 - Data not required, only the “headings” of the HAZOP worksheet
- Develop Algorithms to “Mine” PHA data
 - What hazards are typically associated with this equipment?
 - What consequence is typically associated with this event?
 - What safeguards are typically used to prevent this scenario?



Designed for Safety, Security, and Reliability

Contact

info@kenexis.com