KENEXIS


# Open Data Schema

## For Process Safety Applications

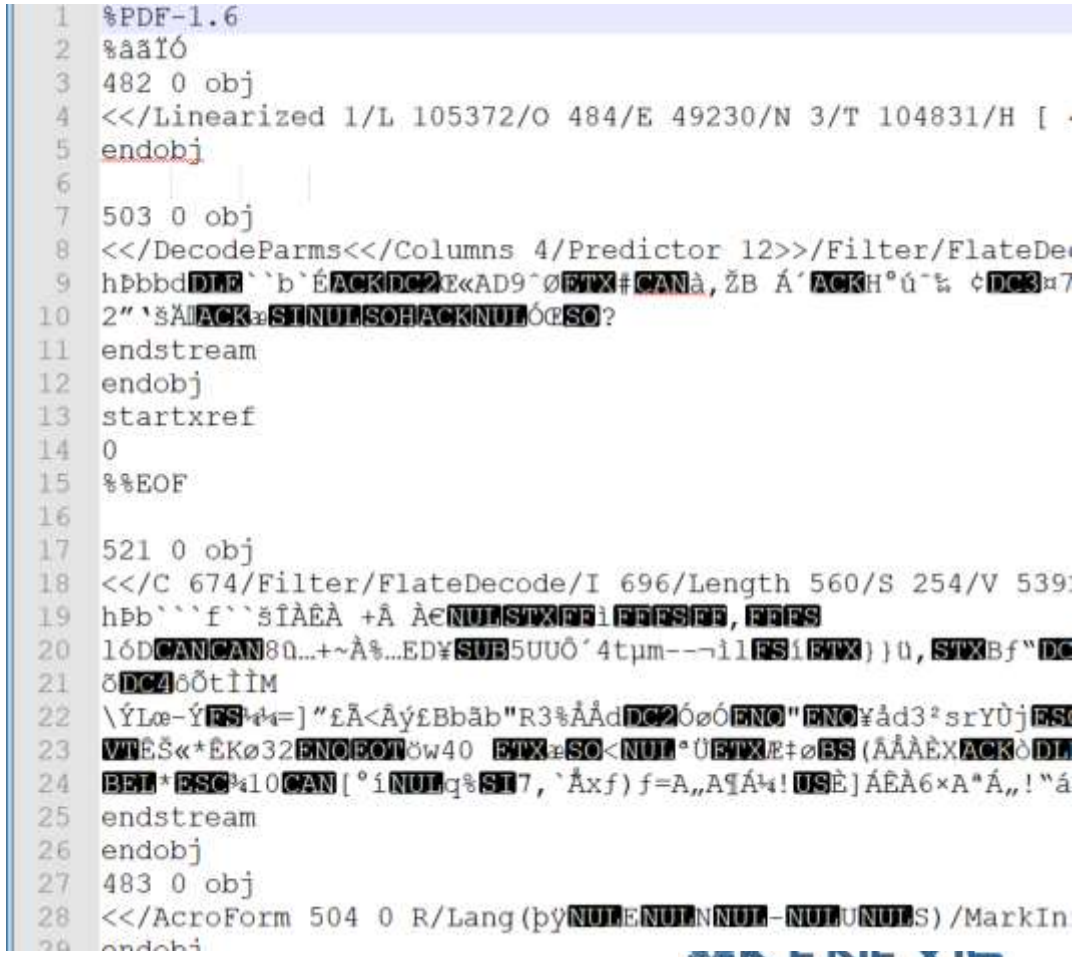
# Proprietary Closed Software is the Norm

- 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 |



# 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

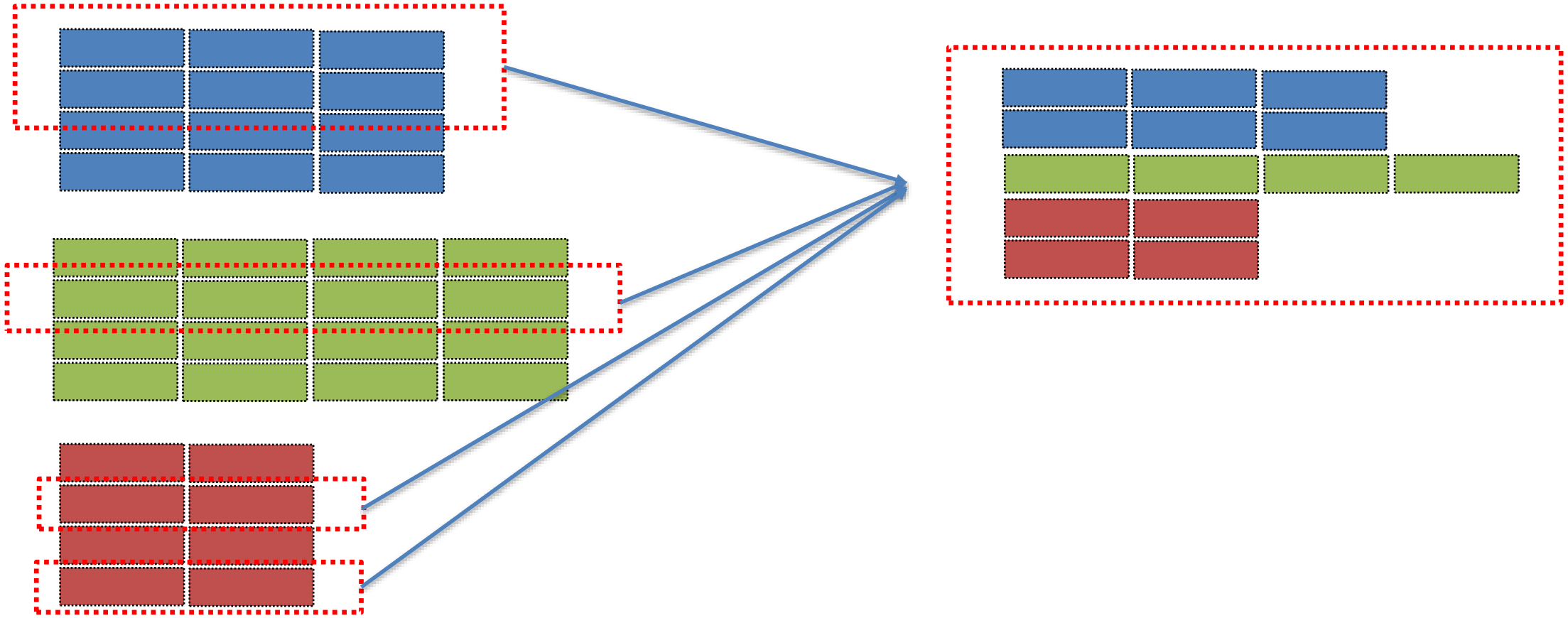
Read JSON.html ● stream.json ✕

```
{
    "streamName": "001",
    "temperature": "273",
    "temperatureUnits": "F",
    "pressure": "450",
    "pressureUnits": "psig",
    "components": [
        {"componentName": "methane", "massFlow": "345.3", "massFlowUnits": "lbs/hr"},
        {"componentName": "ethane", "massFlow": "45.3", "massFlowUnits": "lbs/hr"},
        {"componentName": "propane", "massFlow": "2.34", "massFlowUnits": "lbs/hr"}
        ]
}
```

# 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 ×

```json
{
    "streamName": "001",
    "temperature": "273",
    "temperatureUnits": "F",
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    "pressureUnits": "psig",
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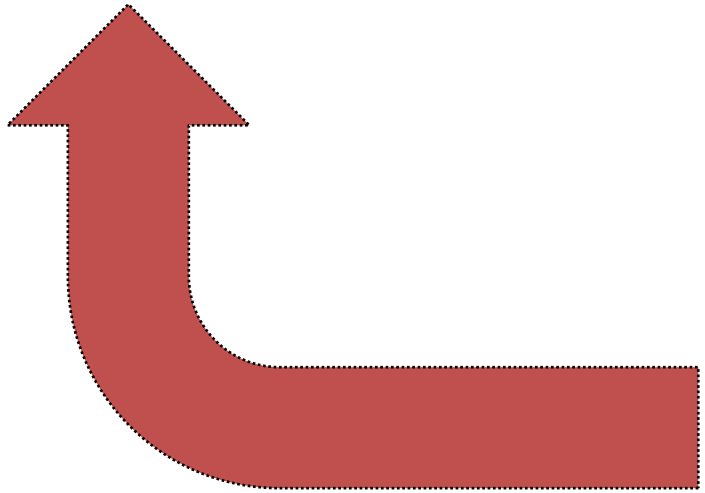
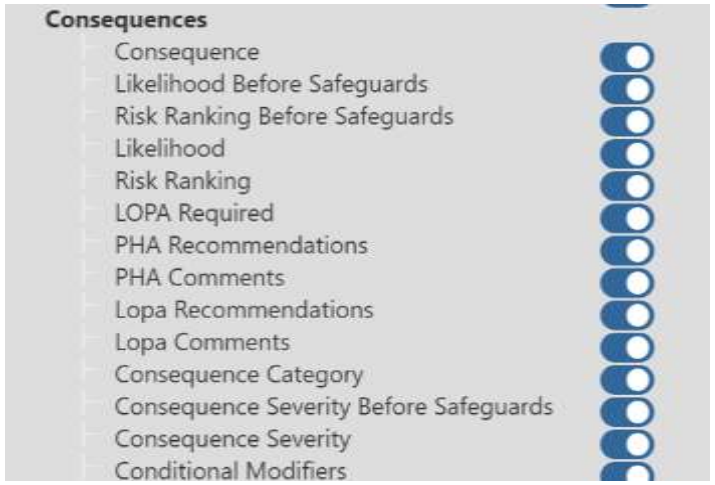
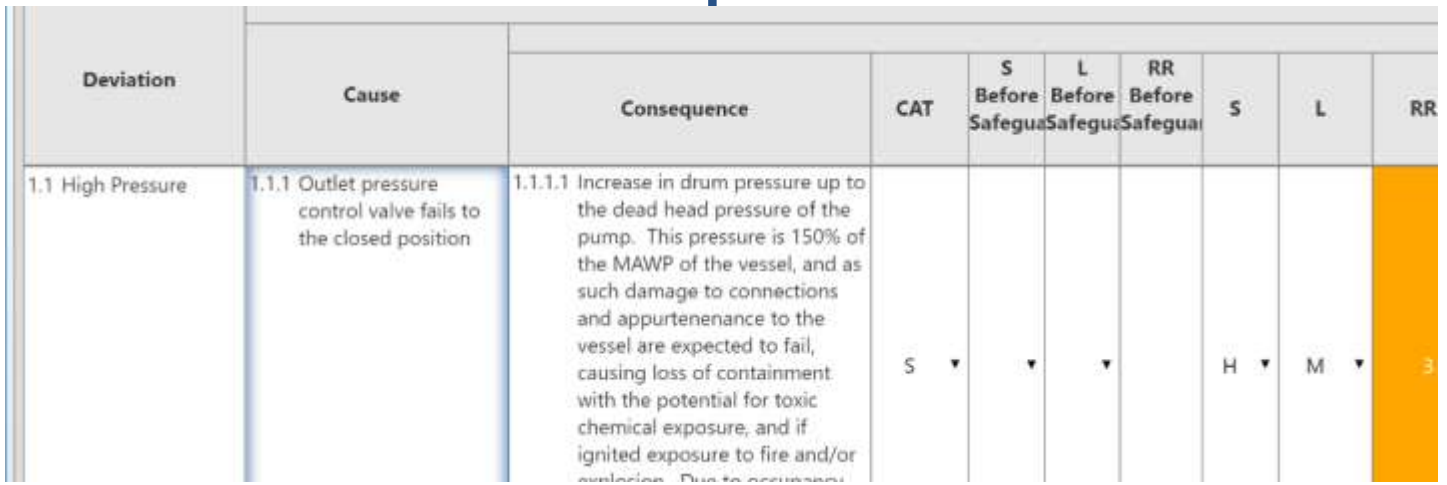


```json
{
  "$id": "http://example.com/example.json",
  "type": "object",
  "definitions": {},
  "$schema": "http://json-schema.org/draft-07/schema#",
  "properties": {
    "streamName": {
      "$id": "/properties/streamName",
      "type": "string",
      "title": "The Streamname Schema ",
      "default": "",
      "examples": [
        "001"
      ]
    },
    "temperature": {
      "$id": "/properties/temperature",
      "type": "string",
      "title": "The Temperature Schema ",
      "default": "",
      "examples": [
        "273"
      ]
    },
    "temperatureUnits": {
      "$id": "/properties/temperatureUnits",
      "type": "string",
      "title": "The Temperatureunits Schema ",
      "default": "",
      "examples": [
        "F"
      ]
    },
```

# If we can't agree – Customizable "Super-Set"



| Deviation | Cause | Consequence | CAT | S Before Safegua | L Before Safegua | RR Before Safegua | 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 appurtenenance 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 | S | | | | H | M | |


| Deviation | Cause | Consequence | CAT | S | L | RR |
|---|---|---|---|---|---|---|
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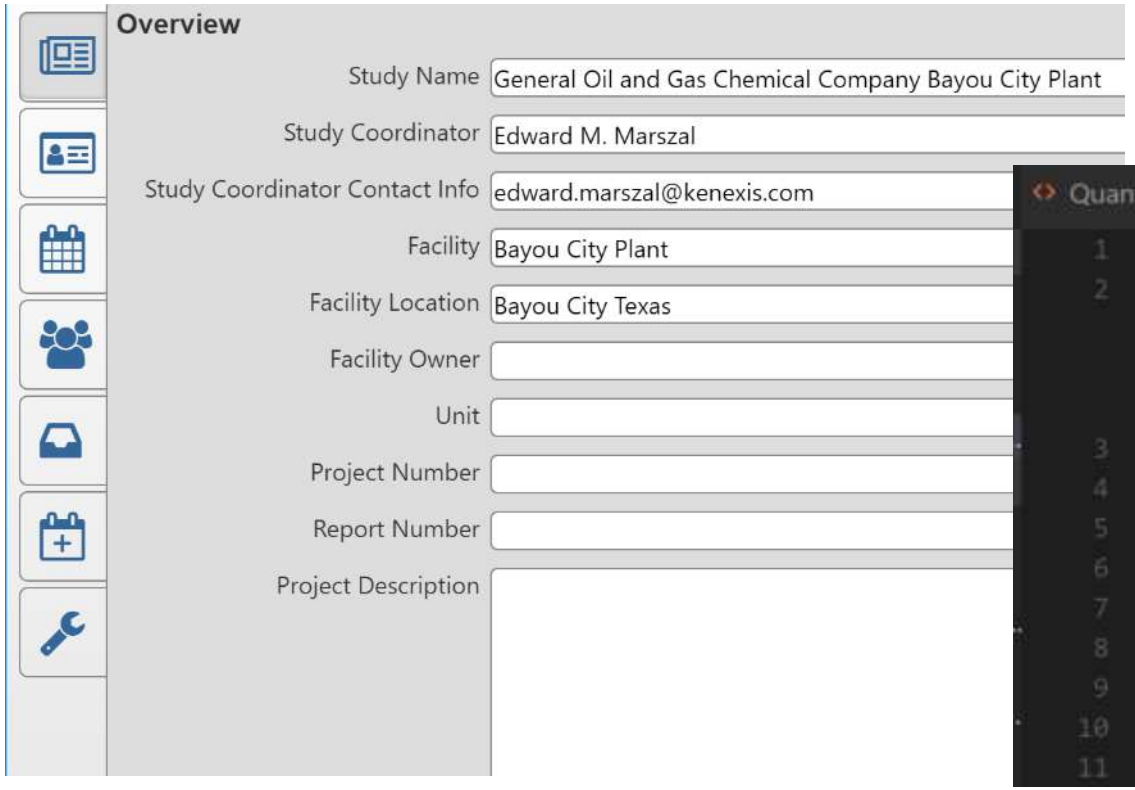
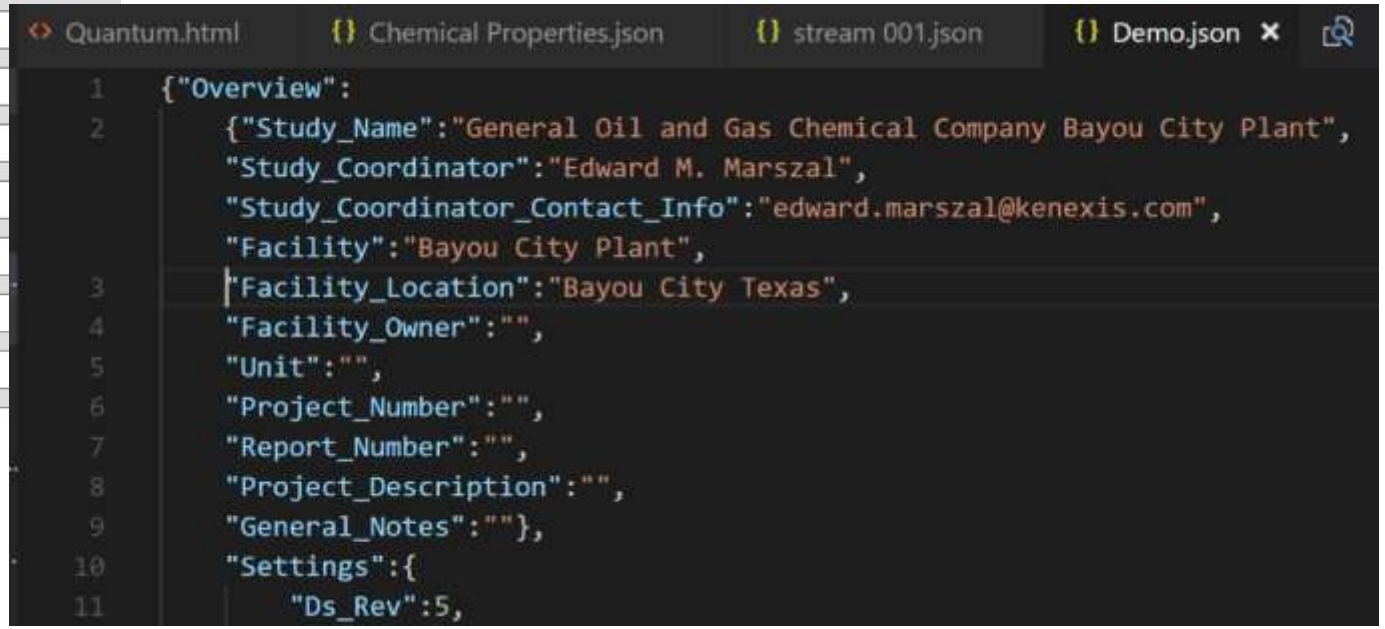
# Implications of Standard JSON Schema

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



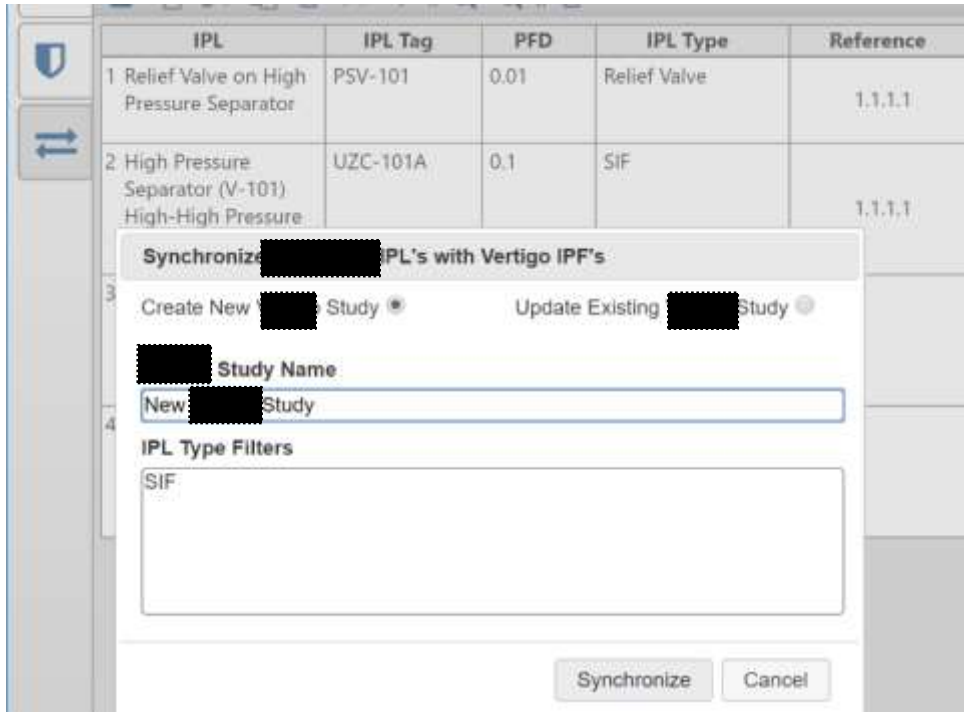
# Potential Applications

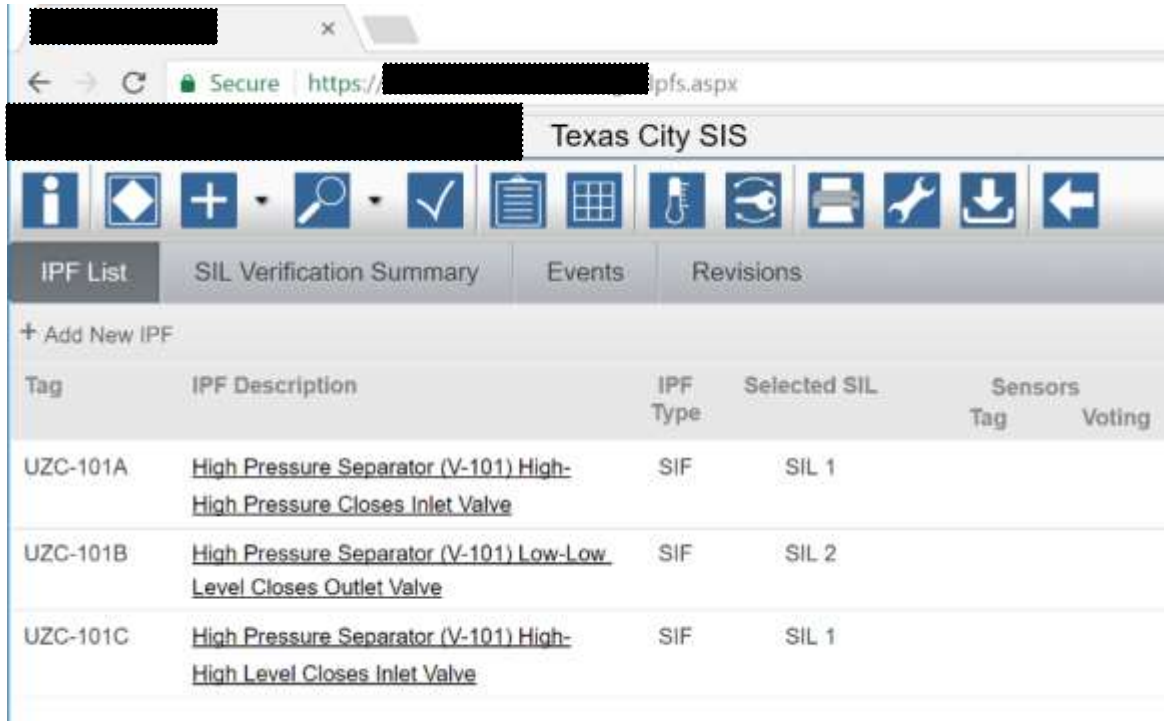
- Process simulators create stream data objects to pass to consequence analysis software
- Consequence analysis software creates dispersion model objects to pass to gas detection mapping software
- HAZOP software creates safety instrumented function objects to pass to SIL verification software
- SIL 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




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?

KENEXIS


# Contact

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