Requirements

Introduction

The following document contains an initial set of requirements for the Pipeline Integrity Evaluation application assignment. There are more requirements that could be added for this project, for example system and sub-system level requirements. These are not present due to time constraints. It should be noted that while Federal regulations 49 CFR Part 192 is referenced, it has not been fully examined for all possible impact on the requirements for the application.

Terminology

- **AGS:** Assignment Goal Statement. Used to clarify that the source of a requirement is from the Assignment Goal Statement.
- **GIS:** Geographic Information System.
- **PIE App:** Pipeline Integrity Evaluation application.
- **Threat Priority:** A classification of an anomaly's threat to pipeline integrity.
- **Pipeline Segment:** An individually identifiable portion of a pipeline. Nominally this is each individual physical pipe that makes up a pipeline.

References

- PART 192 – TRANSPORTATION OF NATURAL AND OTHER GAS BY PIPELINE

Assignment Goal Statement

The following is the goal statement provided with the assignment.

"Design the architecture of a Pipeline Integrity Evaluation application for oil and gas pipelines. The goal is to ensure the ongoing assessment and monitoring of the structural integrity of pipelines, focusing on detecting potential threats, preventing incidents, and prioritizing maintenance activities."

Assignment Requirements

The following are the requirements provided with the assignment. These requirements, federal regulations, and the goal statement serve as the basis of all requirements.

ID	Description
AR.1	The application should integrate with the GIS application/framework to enable the visualization of pipeline integrity data on geographical maps.
AR.2	The application should be able to connect to different sources of information to combine Inline Inspections (ILI) and Non-Destructive Testing reports.
AR.3	A database storing pipe metrics is available. It contains ~100 fields with millions of records per pipe. Sample fields are wall thickness, corrosion, and potential defects.

ID	Description
AR.4	For the Threat Identification and Predictive Maintenance analysis the application should be able to connect to Machine Learning services to get this information.

Possible Questions

The following are questions that may be asked about the design. The presentation is built around answering these questions.

- What cloud services do you suggest?
- What security concerns can you identify?
- How might you connect an on-premise database with the cloud system?
- What tradeoffs do you see between storing data in the cloud vs on-premises?

Derived Requirements

These are the requirements that were derived from the Assignment Requirements.

User Requirements

The following are User Level requirements. These requirements are high level functionality requests from the perspective of the user.

ID	Description	Source
	Anomaly Requirements	
UR.1	The PIE App shall be able to allow a user to manually assess the integrity of the pipes.	AGS
UR.2	The PIE App shall provide an automated Assessment of the integrity of the pipes.	AGS
UR.3	The PIE App shall allow a user to add anomalies in pipe data.	AGS
UR.4	The PIE App shall allow a user to modify anomalies in pipe data.	AGS
UR.5	The PIE App shall allow a user to delete anomalies in pipe data.	AGS
UR.6	The PIE App shall allow a user to assign a threat priority to anomalies.	AGS
UR.7	The PIE App shall provide an automated Assessment of anomalies in pipe data.	AGS
UR.8	The PIE App shall, when creating an automated Assessment, assign a threat priority to each detected anomaly.	AGS
	Notification Requirements	
UR.9	The PIE App shall notify users when a previously detected low threat priority anomaly increases its threat rating due to calculated erosion rates.	AGS
UR.10	The PIE App shall notify users when a monitoring service has detected a threat to pipeline integrity.	AGS

ID	Description	Source
	Display Requirements	
UR.11	The PIE App shall provide a visualization of pipeline integrity data on geographical maps.	AR.1
UR.12	The PIE App shall integrate a GIS application/framework.	AR.1
UR.13	The PIE App shall be able to display pipe metrics to the user.	AR.3
	Data Sources Requirements	
UR.14	The PIE App shall be able to connect to Inline Inspections (ILI) data sources.	AR.2
UR.15	The PIE App shall be able to connect to Non-Destructive Testing Report data sources.	AR.2
UR.16	The PIE App shall be able combine Inline Inspections (ILI) and Non-Destructive Testing Report data.	AR.2
UR.17	The PIE App shall be able to connect to a database storing pipe metrics.	AR.3
UR.18	The PIE App shall allow a user to connect the app to pipeline monitoring services and devices.	AGS
UR.19	The PIE App shall be able to connect to Machine Learning services to retrieve Threat Identification and Predictive Maintenance data.	AR.4
	Assessment Requirements	
UR.20	The PIE App shall allow a user to create, modify, store, and delete an Assessment.	AGS
UR.21	The PIE App shall allow a user to export an Assessment from the application.	AGS
	Pipeline Type Requirements	
UR.22	The PIE App shall provide, load, modify, store, and calculate data as needed for regulatory purposes for oil pipelines.	Part 192
UR.23	The PIE App shall provide, load, modify, store, and calculate data as needed for regulatory purposes for gas pipelines.	Part 192
UR.24	The PIE App shall provide, load, modify, store, and calculate data as needed for business purposes for oil pipelines.	AGS
UR.25	The PIE App shall provide, load, modify, store, and calculate data as needed for business purposes for gas pipelines.	AGS
	Activity Requirements	
UR.26	The PIE App shall be able to display scheduled maintenance activities.	AGS
UR.27	The PIE App shall be able to allow a user to add, modify, and delete maintenance activities.	AGS

ID	Description	Source
UR.28	The PIE App shall be able to automatically recommend maintenance activities based on generated Assessments.	AGS
UR.29	The PIE App shall be able to display scheduled inspection activities.	AGS
UR.30	The PIE App shall be able to allow a user to add, modify, and delete inspection activities.	AGS
UR.31	The PIE App shall be able to automatically recommend inspection activities based on generated Assessments.	AGS
UR.32	The PIE App shall be able to display scheduled testing activities.	AGS
UR.33	The PIE App shall be able to allow a user to add, modify, and delete testing activities.	AGS
UR.34	The PIE App shall be able to automatically recommend testing activities based on generated Assessments.	AGS
	Evaluation Report Requirements	
UR.35	The PIE App shall be able to create an Evaluation Report of one or more Assessments.	AGS
UR.36	The Evaluation Report shall denote the threats to pipeline integrity for the assessed pipelines.	AGS
UR.37	The Evaluation Report shall denote geospatial data for the assessed pipelines.	AGS

Project Requirements

The following are Project Requirements. These requirements define mid-level features that have been derived from the User Requirements.

ID	Description	Source
	Inline Inspection Requirements	
PR.1	The PIE App shall allow a user to open an Inline Inspection.	UR.14
PR.2	The PIE App shall allow a user to close an Inline Inspection.	UR.14
PR.3	The PIE App shall allow a user to add an Inline Inspection to an Assessment.	UR.14, UR.24, UR.25
PR.4	The PIE App shall allow a user to remove an Inline Inspection to an Assessment.	UR.14, UR.24, UR.25
	Non-Destructive Testing Report Requirements	
PR.5	The PIE App shall allow a user to open a Non-Destructive Testing Report.	UR.15
PR.6	The PIE App shall allow a user to close a Non-Destructive Testing Report.	UR.15

ID	Description	Source
PR.7	The PIE App shall allow a user to add a Non-Destructive Testing Report to an Assessment.	UR.15, UR.24, UR.25
PR.8	The PIE App shall allow a user to remove a Non-Destructive Testing Report to an Assessment.	UR.15, UR.24, UR.25
	Display Requirements	
PR.9	The PIE App shall be able to display pipe metrics data for selected pipe segments.	UR.17
PR.10	The PIE App shall be able to display a set of pipe metrics data for one or more selected pipe segments.	UR.17
PR.11	The PIE App shall allow a user to filter pipe metrics data.	UR.17
PR.12	The PIE App shall display the geospatial data associated with a pipeline segment.	UR.11, UR.13
	Rendering Requirements	
PR.13	The PIE App shall render geographic data for the region around a pipeline.	UR.12
PR.14	The PIE App shall allow a user to select a topographical rendering of geographic data.	UR.12
PR.15	The PIE App shall allow a user to select a textured satellite rendering of geographic data.	UR.12
PR.16	The PIE App shall render a pipeline segment according to its geospatial data on a geographic map.	UR.11
PR.17	The PIE App shall render pipeline segments based on their geospatial positions on a geographic map.	UR.11
PR.18	The PIE App shall render pipeline integrity threats on a geographic map via a color map.	UR.11
PR.19	The PIE App shall render pipeline integrity threats on a geographic map via associated symbols.	UR.11
PR.20	The PIE App shall render Inline Testing data to allow for manual user assessment.	UR.1
PR.21	The PIE App shall render Non-Destructive test data to allow for manual user assessment.	UR.1

ID	Description	Source
	Assessment Requirements	
PR.22	The PIE App shall provide an automated Assessment for oil pipeline evaluation data.	UR.2, UR.22, UR.24
PR.23	The PIE App shall provide an automated Assessment for gas pipeline evaluation data.	UR.2, UR.23, UR.25
PR.24	The PIE App shall be able to generate a PDF Evaluation Report based on one or more selected Assessments.	UR.20, UR.21
PR.25	The PIE App shall allow Inline Inspection data to be added to an Assessment.	UR.16
PR.26	The PIE App shall allow Non-Destructive test data to be added to an Assessment.	UR.16
	Schedule Requirements	
PR.27	The PIE App shall recommend maintenance schedules.	UR.28
PR.28	The PIE App shall prioritize maintenance activities based on pipeline data.	UR.17, UR.28
PR.29	The PIE App shall prioritize maintenance activities based on regulatory requirements.	UR.22, UR.23, Part 192
PR.30	The PIE App shall recommend inspection schedules.	UR.31
PR.31	The PIE App shall prioritize inspection activities based on pipeline data.	UR.17, UR.31
PR.32	The PIE App shall prioritize inspection activities based on regulatory requirements.	UR.22, UR.23, Part 192
PR.33	The PIE App shall recommend testing schedules.	UR.34
PR.34	The PIE App shall prioritize testing activities based on pipeline data.	UR.17, UR.34
PR.35	The PIE App shall prioritize testing activities based on regulatory requirements.	UR.22, UR.23, Part 192
PR.36	The PIE App shall be able to integrate with a schedule API for activities.	UR.26, UR.29, UR.32, UR.27, UR.30, UR.33
	Pipeline Location Requirements	
PR.37	The PIE App shall provide a means for the pipeline location to be defined on a geographic map manually.	UR.11, UR.12
PR.38	The PIE App shall provide a means for the pipeline locations to be defined on a geographic map via files.	UR.11, UR.12

ID	Description	Source
PR.39	The PIE App shall provide a means for the pipeline locations to be defined on a geographic map via an API.	UR.11, UR.12
	Assessment Requirements	
PR.40	The Assessment shall denote which pipeline(s) have been evaluated.	UR.7, UR.20
PR.41	The Assessment shall denote potential threats to the evaluated pipeline(s)' integrity based on the pipeline data.	UR.8
PR.42	The Assessment shall contain a geographic rendering of where the evaluated pipeline(s) are.	UR.11
	Evaluation Report Requirements	
PR.43	The Evaluation Report shall denote which Assessment(s) are in the report.	UR.35
PR.44	The Evaluation Report shall denote which pipeline(s) have been evaluated in each Assessment.	UR.7, UR.35
PR.45	The Evaluation Report shall denote potential threats to pipeline integrity based on the pipeline data in each Assessment.	UR.36
PR.46	The Evaluation Report shall contain a geographic rendering of where the evaluated pipeline(s) are in each Assessment.	UR.37
	User Interface Requirements	
PR.47	The PIE App shall allow a user to select a set of pipeline data and add it to an Assessment as an anomaly.	UR.3
PR.48	The PIE App shall allow a user to select an anomaly, in an Assessment, and modify its length.	UR.4
PR.49	The PIE App shall allow a user to select an anomaly, in an Assessment, and modify its width.	UR.4
PR.50	The PIE App shall allow a user to select an anomaly, in an Assessment, and modify its depth.	UR.4
PR.51	The PIE App shall allow a user to select an anomaly, in an Assessment, and remove it from the Assessment.	UR.5
PR.52	The PIE App shall allow a user to select an anomaly, in an Assessment, and assign a threat priority to it.	UR.6
	Notification Requirements	
PR.53	The PIE App shall allow the user to register an email to receive notifications.	UR.9, UR.10

ID	Description	Source
PR.54	The PIE App shall allow the user to register a phone number to receive notification texts.	UR.9, UR.10
PR.55	The PIE App shall calculate estimated error rates for pipeline data at a specified internal rate.	UR.9
PR.56	The PIE App shall allow its error rate check interval to be set by a user.	UR.9
	Monitoring Requirements	
PR.57	The PIE App shall provide a means for monitoring services and devices to provide data to the application.	UR.10, UR.18
PR.58	The PIE App shall provide a means for a user to configure connected monitoring services and devices.	UR.10, UR.18
	Machine Learning Requirements	
PR.59	The PIE App shall provide a means for machine learning services to provide data to the application.	UR.19
PR.60	The PIE App shall provide a means for a user to configure connected machine learning services.	UR.19

Possible areas for additional requirements

The following are possible areas from which to consider additional requirements.

- General requirements for screens, configuration capabilities, user controls, and user experience approaches.
- Monitoring services for: Active Sensors, Weather, Earthquakes, Construction, Military Engagements, Non-governmental activities, Mining, Drilling, and Excavations.
- How anomalies are prioritized.
- How the app allows a user to manually inspect anomaly data.
- How the app allows a user to set thresholds for determining anomaly priorities.
- How the app makes pressure failure predictions based on wall thickness, pipe material, liquid type, and pressure.
- Could the app allow pipeline data to be compared for one or more segments?

Open Questions

The following are open questions created during the design assignment.

- Are there differences between the data for oil and gas pipelines?
- Should this be a web app or a native application? There are many benefits to native applications, but cross platform implementation is more effort.
  - Is a laptop provided to the end customer?
  - Is there a need to allow customers to evaluate data on Mac OS or Linux?
  - Is there a need for a mobile client?

- Is it best to have third party connections flow through the web server?
- Should a web client ever connect to a third party service directly?
- Can incidents be prevented via machine learning?
    - As in using historical data to highlight areas of concern.
- Is there a difference between a 'pipe' and a 'pipeline'?
- What is ID/OD? in this video @2:53: https://www.youtube.com/watch?v=sBw3ewE1xsg
- Based on this video @043: https://www.youtube.com/watch?v=I4PZ0sN3fVw, it appears that scanning isn't done across the entire pipe, but only at welds?
    - Maybe this is only for high resolution scans?
    - Perhaps this is only for specific tools?
- Is data transmitted down a wire or stored on the pig?
- How should data backups be set up for the design?
- What does OD Changes mean?
- Should a vector database be used for the ML data?
    - Is this needed as standard databases now support Vector Data?