Below is one example software specification that defines a set of Python API functions. These functions are designed to cover the range of instructions provided—from creating visualizations to compiling detailed reports and summaries. In some cases, a single function is parameterized so that it can be used in multiple contexts. You can further extend or refactor these APIs based on evolving requirements.

**1. Generate Visualizations**

**Function Name**: generate\_visualizations  
**ID**: 2\_9, 12\_8, 25\_7, 68\_8, 13\_9, 3\_6  
**Purpose**:  
Generate various types of visualizations (e.g., time series plots, heatmaps, box plots, scatter plots, overlay maps) from the given data. This function is used to illustrate recurring equipment chains, statistical distributions, wafer pattern correlations, and other insights as required by multiple instructions.  
**Signature**:

def generate\_visualizations(data, chart\_type, title=None, x\_axis=None, y\_axis=None, \*\*kwargs):

"""

Generate a visualization based on the provided data and chart type.

Parameters:

data: The dataset to visualize.

chart\_type: The type of chart to generate (e.g., 'time\_series', 'heatmap', 'box', 'scatter', 'overlay').

title: Optional title for the visualization.

x\_axis: Optional parameter for the x-axis.

y\_axis: Optional parameter for the y-axis.

\*\*kwargs: Additional keyword arguments for customization.

Returns:

A visualization object or file.

"""

**Used For**:

* *Workflow 2\_9*: Create time series plots and equipment chain usage heatmaps.
* *Workflow 12\_8*: Generate box plots, histograms, and scatter plots for E-test parameter distributions.
* *Workflow 25\_7*: Depict relationships between recurring patterns and probe cards/test programs (bar charts, heatmaps).
* *Workflow 68\_8*: Create detailed visualizations (wafer maps, timelines, correlation plots) for analysis results.
* *Workflow 13\_9*: Illustrate correlation findings using scatter plots and heat maps.
* *Workflow 3\_6*: Display overlay maps or correlation charts for unusual wafer patterns.

**2. Generate Report**

**Function Name**: generate\_report  
**ID**: 10\_7, 19\_7, 23\_7, 26\_8, 27\_8, 28\_7, 35\_5, 40\_7, 42\_10, 43\_7, 48\_7, 49\_9, 50\_7, 54\_8, 56\_8, 69\_8, 70\_7, 72\_4, 76\_6, 77\_5, 9\_6, 5\_8, 24\_6  
**Purpose**:  
Compile and format findings—optionally integrating visualizations, statistical results, and recommendations—into a report. This general-purpose reporting function is used for generating analysis reports, comprehensive reviews, and summary documents as required by many instructions.  
**Signature**:

def generate\_report(report\_data, report\_type="summary", visualizations=None, statistical\_results=None, recommendations=None):

"""

Generate a report based on provided data and parameters.

Parameters:

report\_data: Data or findings to be included in the report.

report\_type: Type of report ('summary', 'analysis', 'comprehensive').

visualizations: Optional visualizations to embed in the report.

statistical\_results: Optional statistical analysis results.

recommendations: Optional recommendations or insights.

Returns:

A report object or file.

"""

**Used For**:

* *Workflow 10\_7*: Report on top three test programs impacting yield.
* *Workflow 19\_7*: Analysis report compiling statistical results and visualizations.
* *Workflow 23\_7*: Report highlighting key differences and implications on yield performance.
* *Workflow 26\_8*: Report and visualizations showing relationships between test measurements and yield issues.
* *Workflow 27\_8*: Report with recommendations linking equipment changes to logical test failures.
* *Workflow 28\_7*: Comprehensive analysis report summarizing test measurement performance trends.
* *Workflow 35\_5*: Report compiling highlighted wafer information.
* *Workflow 40\_7*: Report including analysis, visualization, and summary statistics for decision-making.
* *Workflow 42\_10*: Comprehensive report on yield trends, flagged weeks, and correlations.
* *Workflow 43\_7*: Report detailing analysis, visualizations, and insights on test program comparisons.
* *Workflow 48\_7*: Comprehensive report with numerical results and visualizations on yield performance impact.
* *Workflow 49\_9*: Report summarizing analytical results, visualizations, and yield improvement recommendations.
* *Workflow 50\_7*: Report summarizing monthly yield performance with calculations and comparisons.
* *Workflow 54\_8*: Detailed report with visualizations for failure distributions by test bin.
* *Workflow 56\_8*: Analysis report highlighting significant correlations, potential causes, and recommendations.
* *Workflow 69\_8*: Comprehensive report with correlation analysis and actionable insights.
* *Workflow 70\_7*: Summary report compiling analyses and visualizations for review.
* *Workflow 72\_4*: Report summarizing the total die count on the last wafer.
* *Workflow 76\_6*: Report/chart displaying top failing test measurements and failure counts.
* *Workflow 77\_5*: Report summarizing the total number of tests executed.
* *Workflow 9\_6*: Report/list of wafers with consistent yield below 95%.
* *Workflow 5\_8*: Report summarizing the impact of test measurement families on yield.
* *Workflow 24\_6*: Analysis report highlighting the test program contributing most to die failures.

**3. Generate Histogram**

**Function Name**: generate\_histogram  
**ID**: 29\_5  
**Purpose**:  
Create a histogram that displays the frequency distribution for a selected E-test measurement across wafers in the latest lot.  
**Signature**:

def generate\_histogram(data, measurement, bins=10, title=None, \*\*kwargs):

"""

Generate a histogram for the selected E-test measurement.

Parameters:

data: The dataset containing the E-test measurements.

measurement: The specific measurement to generate a histogram for.

bins: Number of bins for the histogram.

title: Optional title for the histogram.

\*\*kwargs: Additional keyword arguments for customization.

Returns:

A histogram visualization object.

"""

**Used For**:

* *Workflow 29\_5*: Creating a frequency distribution of the selected E-test measurement.

**4. Plot Yield Trend**

**Function Name**: plot\_yield\_trend  
**ID**: 74\_5, 36\_5  
**Purpose**:  
Plot yield trends over time by creating a chart (line or bar) with weeks on the x-axis and yield percentages on the y-axis. This supports both simple yield trend charts and more detailed lot-level yield trend analyses.  
**Signature**:

def plot\_yield\_trend(yield\_data, time\_period, chart\_type="line", title=None, \*\*kwargs):

"""

Plot yield trend over a specified time period.

Parameters:

yield\_data: Data containing yield percentages over time.

time\_period: The time period (e.g., list of weeks) for the x-axis.

chart\_type: Type of chart to plot (default is 'line').

title: Optional title for the chart.

\*\*kwargs: Additional customization parameters.

Returns:

A yield trend chart visualization.

"""

**Used For**:

* *Workflow 74\_5*: Create a simple yield trend chart for the past three weeks.
* *Workflow 36\_5*: Plot the trend of lot-level yield over the last 6 weeks.

**5. Summarize E-test Measurements**

**Function Name**: summarize\_etest\_measurements  
**ID**: 36\_5 (Summarize Results for E-test measurements)  
**Purpose**:  
Generate a summary table or report listing each wafer alongside its count of E-test measurements.  
**Signature**:

def summarize\_etest\_measurements(data, wafer\_column, measurement\_column, title=None):

"""

Summarize E-test measurements per wafer.

Parameters:

data: Dataset containing wafer and E-test measurement data.

wafer\_column: The column name representing wafers.

measurement\_column: The column name for E-test measurements.

title: Optional title for the summary table/report.

Returns:

A summary table or report of E-test measurements count per wafer.

"""

**Used For**:

* *Workflow 36\_5*: Summarize the number of E-test measurements per wafer.

**6. Display Die Summary**

**Function Name**: display\_die\_summary  
**ID**: 60\_5  
**Purpose**:  
Display a summary of passing versus failing dies for a specified wafer, aiding quick assessment of wafer quality.  
**Signature**:

def display\_die\_summary(die\_data, wafer\_id, title=None):

"""

Display a summary of passing versus failing dies for a specific wafer.

Parameters:

die\_data: Dataset containing die test results.

wafer\_id: Identifier for the wafer.

title: Optional title for the summary.

Returns:

A summary report or table of pass/fail counts.

"""

**Used For**:

* *Workflow 60\_5*: Show the tally of passing vs. failing dies on the most recent wafer.

**7. Present Test Program Status**

**Function Name**: present\_test\_program\_status  
**ID**: 8\_6  
**Purpose**:  
Present the pass/fail status for each test program on a selected wafer using a report or visualization format.  
**Signature**:

def present\_test\_program\_status(test\_program\_data, wafer\_id, title=None):

"""

Present pass/fail status for each test program on a selected wafer.

Parameters:

test\_program\_data: Data containing test program results.

wafer\_id: Identifier for the selected wafer.

title: Optional title for the presentation.

Returns:

A report or visualization object showing pass/fail status.

"""

**Used For**:

* *Workflow 8\_6*: Show the pass/fail status of each test program for a specific wafer.

**8. Visualize Failing Test Measurements**

**Function Name**: visualize\_failing\_test\_measurements  
**ID**: 76\_6  
**Purpose**:  
Generate a visualization (or combined report) that highlights the top failing test measurements along with their failure counts. This aids in identifying the test measurements most frequently linked to yield issues.  
**Signature**:

def visualize\_failing\_test\_measurements(data, title=None, top\_n=5, \*\*kwargs):

"""

Visualize the top failing test measurements along with their failure counts.

Parameters:

data: Dataset containing test measurement failure counts.

title: Optional title for the visualization.

top\_n: Number of top failing test measurements to display.

\*\*kwargs: Additional customization parameters.

Returns:

A visualization object highlighting failing test measurements.

"""

**Used For**:

* *Workflow 76\_6*: Display top failing test measurements and their failure counts.

**9. Format Die Count Report**

**Function Name**: format\_die\_count\_report  
**ID**: 72\_4  
**Purpose**:  
Format and output the total die count for the last wafer into a concise report or message for quick review.  
**Signature**:

def format\_die\_count\_report(die\_count, wafer\_id, title=None):

"""

Format the total die count into a summarized report.

Parameters:

die\_count: The total number of dies tested.

wafer\_id: Identifier for the wafer.

title: Optional title for the report.

Returns:

A formatted report string or object summarizing the die count.

"""

**Used For**:

* *Workflow 72\_4*: Report the total number of dies tested on the last wafer.

**10. Compile Underperforming Wafers**

**Function Name**: compile\_underperforming\_wafers  
**ID**: 9\_6  
**Purpose**:  
Compile and generate a report or list of wafers that have consistently underperformed (yield below 95% over multiple weeks).  
**Signature**:

def compile\_underperforming\_wafers(wafers\_data, yield\_threshold=95, weeks=None, title=None):

"""

Compile a list of wafers with consistent yield below the specified threshold.

Parameters:

wafers\_data: Dataset containing wafer yield information.

yield\_threshold: Yield percentage threshold (default 95).

weeks: Optional period (e.g., list of weeks) to consider for consistency.

title: Optional title for the report.

Returns:

A report or list of wafers under the yield threshold.

"""

**Used For**:

* *Workflow 9\_6*: Generate a report or list of wafers with consistent yield below 95%.

**11. Report Total Tests Executed**

**Function Name**: report\_total\_tests\_executed  
**ID**: 77\_5  
**Purpose**:  
Generate a summarized report detailing the total number of tests executed over a specified time period.  
**Signature**:

def report\_total\_tests\_executed(test\_data, time\_frame, title=None):

"""

Generate a report summarizing the total number of tests executed.

Parameters:

test\_data: Dataset containing test execution data.

time\_frame: The time period over which tests were executed.

title: Optional title for the report.

Returns:

A report summarizing the total tests executed.

"""

**Used For**:

* *Workflow 77\_5*: Compile the total number of tests executed into a summarized report.

Each function’s design is intentionally modular so that they can be reused across multiple workflows by simply adjusting parameters (such as the chart type, report type, or thresholds). This specification should serve as a strong foundation for implementing the analytics features in the semiconductor chip test data domain.