

# Stacked Reports

## Overview

Stacked reports are a collection of **Sub Reports** that are combined (stacked) together according to a **Stack Rule** to produce the report. Sub reports may contain dependencies between each other.

Below are a few scenarios where sub reports would be used:

- Batch report containing multiple lots
- Process cycle performed over stages e.g., clean in place (CIP) for first rinse, caustic wash, sanitize and drain.
- Product routing over a selection of stations
- Process summary on a selection of assets e.g., OEE over a set of machines.

A common element in each of the above examples is that the report is produced by incrementally adding information to the report.

Sub reports are defined with layout/content, a set of data/management connections and a stacking rule. These concepts will be explained in more detail in this document.

The following examples show the template and the produced report:

- A batch report containing multiple lots

BATCH									
Name		Start Time		End Time		Duration			
						0:00:00			
LOT 0									
Start Time		EndTime		Duration					
Mixer			Extruder			Reactor			
Time	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg

The template contains three sub-reports (red outline). The stacking rule is that for each batch selected, enumerate the lots and for each lot retrieve the process data. This produces a report like the following:

Batch Summary									
BATCH B123-Black									
Name		Start Time		End Time		Duration			
B123-Black		9/8/2022 03:20:00		9/8/2022 08:45:00		5:25:00			
LOT A-1									
Start Time		EndTime		Duration					
3:20		4:40		1:20:00					
Mixer			Extruder			Reactor			
Time	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
3:20	5	80	67.5	5	80	67.5	5	80	67.5
3:40	5	80	67.5	5	80	67.5	5	80	67.5
4:00	5	80	67.5	5	80	67.5	5	80	67.5
4:20	5	80	67.5	5	80	67.5	5	80	67.5
4:40	5	80	67.5	5	80	67.5	5	80	67.5
LOT A-2									
Start Time		EndTime		Duration					
4:45		8:45		4:00:00					
Mixer			Extruder			Reactor			
Time	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
4:45	5	80	67.5	5	80	67.5	5	80	67.5
5:45	5	80	67.5	5	80	67.5	5	80	67.5
6:45	5	80	67.5	5	80	67.5	5	80	67.5
7:45	5	80	67.5	5	80	67.5	5	80	67.5
8:45	5	80	67.5	5	80	67.5	5	80	67.5

- A process cycle using a selection of stations

<b>Station # 1</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)			
Temp. Setpoint (°C)	0	Sonic Power (W)	0				
<b>Station # 2</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)			
Temp. Setpoint (°C)	0	Sonic Power (W)	0				
<b>Station # 3</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)			
Temp. Setpoint (°C)	0	Sonic Power (W)	0				
<b>Station # 4</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
		OSC Out (sec)	0				
Temp. Setpoint (°C)	0						
<b>Station # 5</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
		OSC Out (sec)	0				
Temp. Setpoint (°C)	0						
<b>Station # 6</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)			
Temp. Setpoint (°C)	0						

The template contains six sub-reports (red outline), one for each station. The stacking rule is that for a given basket, the sub report for each station used for that basket is shown in the report. This produces a report like the following:

Basket Report							
Basket Order Number:							
			B125-22				
Start Date:			End Date:			Duration	0
<b>Station # 1</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)			
Temp. Setpoint (°C)	0	Sonic Power (W)	0				
<b>Station # 3</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)			
Temp. Setpoint (°C)	0	Sonic Power (W)	0				
<b>Station # 4</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
		OSC Out (sec)	0				
Temp. Setpoint (°C)	0						
<b>Station # 3</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)			
Temp. Setpoint (°C)	0	Sonic Power (W)	0				
<b>Station # 6</b>		In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)	0		
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)			
Temp. Setpoint (°C)	0						

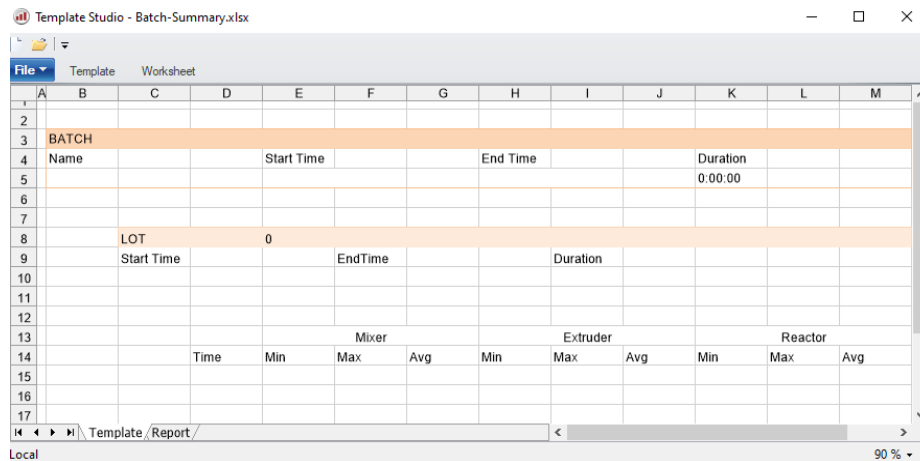
The reports shows the routing of the basket using station in the order #1 > #3 > #4 > #3 > #6

## How do Stacked Reports Work?

The two main elements of a stacked report are the workbook template and a list of items which are used to drive the sub reports to the final report. Since there are several parts to stacked reports, a **Stacked Template Wizard** is provided to simplify the process.

As an illustration, below is the workbook for the *Batch* report described in the previous section.

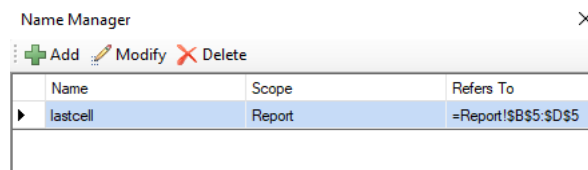
### Workbook Template



The workbook consists of two worksheets:

- **Template** contains the sub reports individually connected to data sources using Data Connections.
- **Report** contains the named cell *LastCell* which is used to locate where the sub report is placed when it is used.

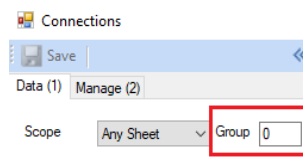
Note that named cells are defined/modified on the **Design** tab of the Template Studio using the **Name Manager**.



The following steps are used to stack a sub report:

- Sub report is copied to *LastCell* on the **Report** sheet.
- The connections assigned to the sub report are updated.
- *LastCell* is automatically moved down on the **Report** sheet (using Data Management) so the next sub report appears below the previous.
- If the data sources in the sub report cause the sub report to grow, this also repositions *LastCell*.

Note the need to control the operations i.e., first copy the sub report with Data Management and then update the Data Connections. The execution order is controlled using connection **Group** IDs. These IDs are defined as part of the **Data Connection**.



To enforce the order of operations, each action is given an ID, for example 10 for the copy and 1 for the update. When the report is updated using the action *UpdateGroupSheet*, these values are listed in the order of execution:

## Data Groups

Now that the general concept of copying sub reports to the *Report* sheet and updating its connections is covered, what causes this to happen i.e., what is the rule governing the stacking?

Stacked reports are driven from a **Stack Master** list of items derived from a data table e.g., the results of a database query, and are processed record by record. For example, the following table shows a list of **Event Frames** (see CONNECT, **Event Frames** in the Document Library) corresponding to batches and lots:

StartDateTime	EndDateTime	Batch	Lot
10/1/2022 5:26:52 PM	10/1/2022 9:30:02 PM	B1093	
10/1/2022 5:27:30 PM	10/1/2022 6:30:32 PM	B1093	Lot 1
10/1/2022 6:31:10 PM	10/1/2022 7:34:12 PM	B1093	Lot 2
10/1/2022 7:34:50 PM	10/1/2022 9:29:09 PM	B1093	Lot 3
10/3/2022 9:32:25 PM	10/4/2022 1:33:20 AM	B1210	
10/3/2022 9:33:03 PM	10/3/2022 10:36:05 PM	B1210	Lot 1
10/3/2022 10:36:43 PM	10/3/2022 11:39:45 PM	B1210	Lot 2
10/3/2022 1:41:25 AM	10/3/2022 5:13:52 AM	B1335	
10/3/2022 1:42:03 AM	10/3/2022 2:45:05 AM	B1335	Lot 1
10/3/2022 2:45:43 AM	10/3/2022 3:48:45 AM	B1335	Lot 2
10/3/2022 3:49:23 AM	10/3/2022 5:12:25 AM	B1335	Lot 3
10/3/2022 6:49:23 AM	10/3/2022 8:12:25 AM	B1335	Lot 4
10/3/2022 1:31:41 PM	10/3/2022 5:36:14 PM	B1507	
10/3/2022 1:32:19 PM	10/3/2022 2:35:21 PM	B1507	Lot 1
10/3/2022 2:35:59 PM	10/3/2022 3:39:01 PM	B1507	Lot 2
10/3/2022 3:39:39 PM	10/3/2022 5:35:21 PM	B1507	Lot 3

To obtain information about a batch, a database group called *grpBatch* would be configured to produce the following query, filtering for the specific batch e.g., *B1335*:

```
SELECT StartDateTime, EndDateTime, Batch
FROM tblBatchLot
WHERE Batch = 'B1335'
AND Lot IS NULL
```

To obtain information about the lots for that batch, a database group called *grpLot* would be configured to produce the following query, filtering for the specific batch:

```
SELECT StartDateTime, EndDateTime, Batch, Lot
FROM tblBatchLot
WHERE Batch = '{grpBatch:Batch}'
AND Lot IS NOT NULL
ORDER BY StartDateTime ASC
```

When database groups are used in the context of stacked reports, they expose their **Columns** values through implicit variables using the syntax *group:column name*. This has been used in the *grpLot* filter where, instead of hard coding a value for the *Batch*, it is assigned the filtered value from *grpBatch:Batch* enclosed in *{}*.

Implicit variables can be used in history groups. For example, to obtain metrics about a particular lot, the history group **Time Period** filter would look like:

Implicit variables can also be displayed in sub reports as **Variable** connections.

## Stacking Rule

As described in the **Overview**, stacked reports have two main elements, the **Sub Reports** which are stacked according to a **Stack Rule**. The stack rule is a hierarchy of data groups which cascade into each other, stacking the sub reports. At the top of the hierarchy is a database group called the **Stack Master** which dictates the processing of all the other groups.

The records may be processed at once (Always rule) or they may provide values to other groups and wait for them to complete (Iterate rule). A third stacking rule is based on a condition (Condition rule) involving an implicit variable, an operator, and a value.

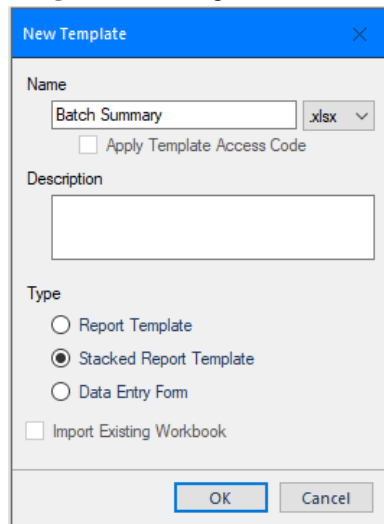
Since there are several considerations that need to be made in creating a stacked report, a **Stacked Template Wizard** is provided to easily attain results.

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## Stack Wizard

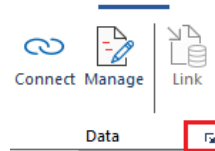
The **Stack Wizard** quickly produces the framework of a stacked report template. It requires information about the sub reports and the stacking rule.

The wizard is launched from the **Design Studio** using the **File, New** options on the menu bar.



- Enter a **Name** for the template.
- For **Type** select **Stacked Report Template**
- Click **OK** to open the wizard dialog.

The wizard can also be accessed in the **Design Studio Connect** tab from the launcher of the **Data** group.



This option is useful when edits are needed to an existing configuration.

Stack Wizard

Template Name: Batch-Summary

Stack Master: grpBatchList

Date Column: StartDateTime

Scheduled

Condition: [Empty]

Filter: Current Day

Rule	Group Name	Connect ID	Variable	Operator	Value
Iterate	grpBatch		101.1		
Iterate	grpLot		102.2		
Always	grpProcess		103.3		

OK Cancel

- **Template Name**  
The **Template Name** is read-only and is the name that was given on the previous step.
- **Stack Master**  
The **Stack Master** is usually set to a database group which return a list of items. Each item in the list will be used to drive the rules specified in the grid.
- **Date Column**  
The **Date Column** is set to a column in the **Stack Master** that represents a date and time. If there no such column, set this to **None**.  
When the report is produced on-demand this setting is used to filter the items in the Database Panel. When the report is **Scheduled**, the **Filter** setting is used to filter the list (see later).

**Stacked Reports** are produced automatically, on-demand, or both.

The on-demand option is always enabled. When used in a windows or web client, the user is presented with the **Stack Master** list in a **Database Panel** (described in a separate document). Selecting one or more items will iteratively drive the rules specified to produce the report.

For automatic reports, the check **Scheduler** and setup a schedule **Condition** and a **Filter**.

- **Condition**  
The **Condition** indicates when the report is scheduled, either **Time** or **Event**. The dialog that displays when the browse [...] is clicked gives the same choices as those in the Schedule Designer (discussed in a separate document).
- **Filter**  
The **Filter** setting indicates the filter that will be applied to the **Stack Master** list before the report is produced. The available choice for the filter depends on the selection for the **Date Column** (see above).

Each row in the grid represents a sub report. When a report is produced, the **Stack Master** list determines the framework of the report. Each item of the list is applied to the rows in the grid top down.

- Group Name

The records of the **Group Name** are retrieved using the implicit variables of the **Stack Master** item and any parent **Rules** that are set to *Iterate*. For each record of the **Group Name**, the **Rule** is checked to see if it is satisfied and, if so, the report is updated using the **Connect ID** setting.

- **Connect ID**

This setting is related to the group IDs of the template and indicates which connections in the template are performed when the row is processed.

Usually this is configured to first copy the sub report target report (management connection) and then populate with data (data connection). When multiple connections IDs are required in this way, they are separated by a comma e.g., *10,1*.

Note that by leaving this setting blank, the row will be processed according to the rule. but it will not affect the content of the report.

- **Rule**

- **Always**

The **Connect ID** is performed for all the records of the data source given by the **Group Name** before the next row in the grid is processed.

- **Iterate**

The **Connect ID** is performed for each record of the data source given by the **Group Name**. Each value in the record is assigned a variable name in the form *group:name* and can be used in other sub reports. With a sub report iterating, all the rows below this row need to be completed before the next record is processed.

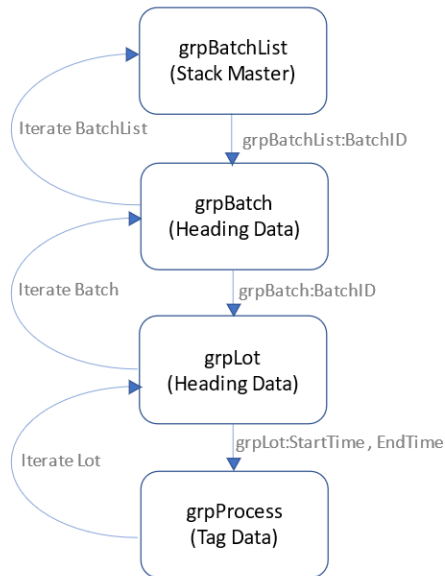
- **Condition**

The **Connect ID** is performed if the **Condition** criteria is met.

Consider **Stack Rules** in the context of the example mentioned in a previous section of this document.

Batch Summary												
BATCH B123-Black												
Name	Start Time				End Time				Duration			
B123-Black	9/8/2022 03:20:00				9/8/2022 08:45:00				5:25:00			
LOT A-1												
Start Time	EndTime				Duration							
3:20	4:40				1:20:00							
			Mixer				Extruder			Reactor		
Time	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
3:20	5	80	67.5	5	80	67.5	5	80	67.5	5	80	67.5
3:40	5	80	67.5	5	80	67.5	5	80	67.5	5	80	67.5
4:00	5	80	67.5	5	80	67.5	5	80	67.5	5	80	67.5
4:20	5	80	67.5	5	80	67.5	5	80	67.5	5	80	67.5
4:40	5	80	67.5	5	80	67.5	5	80	67.5	5	80	67.5
LOT A-2												
Start Time	EndTime				Duration							
4:45	8:45				4:00:00							
			Mixer				Extruder			Reactor		
Time	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
4:45	5	80	67.5	5	80	67.5	5	80	67.5	5	80	67.5
5:45	5	80	67.5	5	80	67.5	5	80	67.5	5	80	67.5
6:45	5	80	67.5	5	80	67.5	5	80	67.5	5	80	67.5
7:45	5	80	67.5	5	80	67.5	5	80	67.5	5	80	67.5
8:45	5	80	67.5	5	80	67.5	5	80	67.5	5	80	67.5

For the Batch Summary report, the **Stack Master** group returns a list of batch records. Each record contains the ID, start time, and end time of a batch.



The stacking process to generate the report is as follows:

1. Stack Master
  - a. Retrieve the batch records from the Stack Master group *grpBatchList*.
  - b. The *Iterate* rule is always applied to the stack master, and the first row is triggered.
2. *grpBatch*
  - a. Process the record returned by the *batch ID* from the **Stack Master** record.
  - b. Generate a batch subreport for this record.
  - c. Apply the *Iterate* rule to trigger the next row.
    - After the last record from this group is processed, return to the parent iteration (*grpBatchList*)
3. *grpLot*
  - a. Retrieve lot records matching the *batch ID* from *grpBatch*.
  - b. Generate a subreport for the first lot.
  - c. Applies the **Iterate** rule to trigger the next **Rule**.
    - After the last record from this group is processed, return to the parent iteration (*grpBatch*)
4. *grpProcess*
  - a. Retrieve process data matching the time frame of the lot record from *grpLot*.
  - b. Generate a subreport for the lot time period.
  - c. Apply the **Always** rule to return to the parent iteration.

The next three columns can only be edited if the **Rule** is set to *Condition*. With the **Rule** as *Condition*, the row in the grid will be processed only if the condition specified is met. The **Condition** consists of a **Variable**, **Operator** and **Value**.

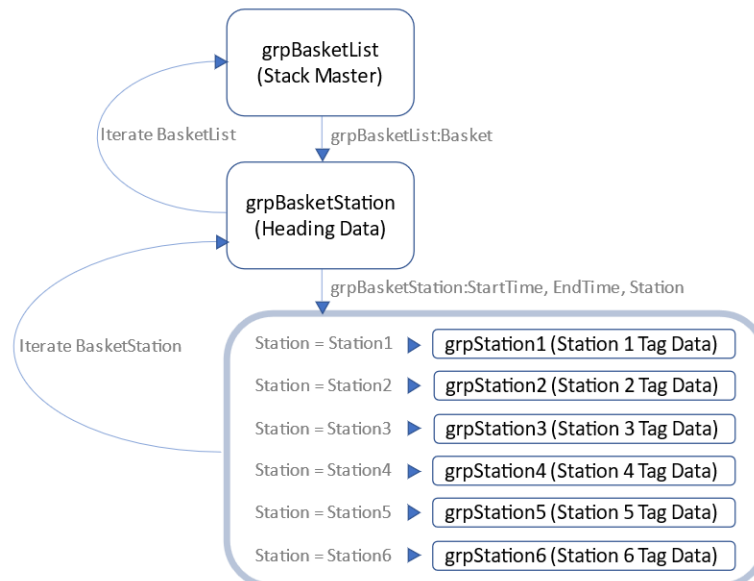
- Enter a **Variable**.  
Select an implicit variable from the list.
- Enter an **Operator**.
- Enter a **Value**.

Consider the **Condition** rule in the context of the example mentioned in a previous section of this document.



Basket Report						
Basket Order Number:			B125-22			
Start Date:			End Date:		Duration	0
<b>Station # 1</b>	In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)		0
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)		
Temp. Setpoint (°C)	0	Sonic Power (W)	0			
<b>Station # 3</b>	In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)		0
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)		
Temp. Setpoint (°C)	0	Sonic Power (W)	0			
<b>Station # 4</b>	In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)		0
		OSC Out (sec)	0			
Temp. Setpoint (°C)	0					
<b>Station # 3</b>	In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)		0
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)		
Temp. Setpoint (°C)	0	Sonic Power (W)	0			
<b>Station # 6</b>	In Date:	12:00 AM	Out Date:	12:00 AM	Duration:	0:00:00
Dwell (sec)	0	OSC In (sec)	0	Drip (sec)		0
Sonic (sec)	0	OSC Out (sec)	0	Agitate (sec)		
Temp. Setpoint (°C)	0					

For the Basket Report, the **Stack Master** returns a list of *Basket IDs*, along with a start and end time for each.



The stacking process to generate the report is as follows:


1. Stack Master
  - a. Retrieve the batch records from the **Stack Master** group *grpBasketList*.
  - b. The **Iterate** rule is always applied to the stack master, and the first row is triggered.
2. grpBasketStation
  - a. Process the record returned by the *basket ID* from the **Stack Master** record.
  - b. Generate a basket subreport for this record.
  - c. Apply the **Iterate** rule to trigger the next row.
    - After the last record from this group is processed, return to the parent iteration (*grpBasketList*)
3. grpStation1 through grpStation6
  - a. the set of **Condition** rules behaves effectively like a switch, or case statement.
    - Based on the value of *Station* in the record returned by *grpBasketStation*, generate a subreport for that time frame and tags corresponding to that station.
    - Return to the parent iteration (*grpBasketStation*)

By clicking **OK**, a template is created by the wizard using the **Name** specified. The **Data** and **Management** connections are created, an input panel for on-demand client is configured (if selected) and a schedule is setup (if selected).

The template theme is taken from workbook *htStack.xlsx* which is in the **\_library\\_Stack** folder of the installation. Since this workbook is used by the wizard, it is suggested that any file changes are limited to color and text.

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## Tutorial

For a tutorial on stacked reports, please refer to the document **xlreporter-training-stacked-reports** which is located in the **\_docs** folder of the installation. Alternatively, from the **Project Explorer**, select the help  button, expand **GETTING STARTED** and select **Report from Stacked Reports**.

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