Chapter 9
Working with Total Fields

Introduction

Total fields are those fields that contain summary information such as subtotal and total figures. The value of a total field is calculated by R&R according to the total options you select. You can create total fields, insert them in reports, and manipulate them just as you do data and text fields.

This chapter explains how to create and use total fields in R&R reports. This information is presented in the following sections:

- ❑ Creating and Editing Totals
- ❑ Customizing Totals
- ❑ Using Total Fields in Reports
- ❑ Using Totals in Calculations
- ❑ Sorting and Querying on Totals

Creating and Editing Totals

You can define summary information such as totals and subtotals for any field in the composite record structure.

Briefly, the procedure you follow to create and use total fields includes these steps:

1. Select Calculations ⇒ Total Field.

2. Using the New/Edit Total dialog box, name the field.

3. Select the type of total from a list that consists of Count, Sum, Average, Minimum, Maximum, Standard Deviation, and Variance.

4. Select the field to total.

5. Select when to reset the total: at the end of the report (Grand), at the end of each page, or after the last record in a numbered group (for any one of 8 groups).

6. Optionally select Condition to make this total a *conditional total*. On the Total Condition dialog enter an expression (referred to as a *condition expression)* that specifies the circumstances in which R&R will calculate this total (see the **Entering a Condition Expression** section of this chapter for more information about conditional totals).

7. Insert the field on your report or use it in another total or calculated field.

The following sections explain each of these steps in detail.

Procedures for Creating Totals

To begin creating a total field, select Calculations ⇒ Total Field or the Total button on the Standard Toolbar. If no totals have yet been defined for the current report, the New Total dialog appears. If one or more totals have already been defined, select New in the Total Fields dialog to display the New Total dialog (see Figure 9.1).

Figure 9.1 New Total Dialog Box (with Options selected)

Entering a Field Name

In the Name edit box, enter a field name of up to 10 characters. The name can contain letters, numbers, or the underscore character; it must start with a letter. The field name must be unique.

By using a combination of upper and lower case, you can enter total field names that are easily distinguishable from the names of table fields.

Select	*To Produce*
Count	Count of the records that contain data in the field. Records that contain no data in the selected field (that is, the field is blank or contains a zero formatted with "Show Zero" turned off) are not included in the count.
Sum	Sum of the values in a numeric or logical field for all records containing data. (True = 1; False = 0).
Average	Average (mean) of the values in a numeric or logical field for all records that contain data. Records in which the field is blank or contains a zero formatted with "Show Zero" turned off are not included in the average.
Minimum	Lowest value for a numeric field, false for a logical field if any records contain false values, earliest date for a date field, first value in alphabetical order for a character field. Only records containing data are considered.
Maximum	Highest value for a numeric field, true for a logical field if any records contain true values, latest date for a date field, last value in alphabetical order for a character field. Only records that contain data are considered.
Std Deviation	For numeric fields, the square root of the variance. R&R calculates this using the following formula, where *n* is the total number of values, v_i is the *i*th value, and *avg* is the average of all values: $$\sqrt{\frac{\Sigma(v_i - avg)^2}{n}}$$
Variance	For numeric fields, the average of $NUMBER^2$ minus (average of $NUMBER)^2$, where NUMBER is a numeric field and the average is computed based on the number of records totaled (not including records with blanks or zeros formatted with "Show Zero" turned off). See the formula illustrated in the explanation of Standard Deviation. Both variance and deviation measure the degree to which individual field values vary from the average of all values totaled.

Figure 9.2 Total Choices

Selecting a Total Type

Select a total type from the Type group box: Count, Sum, Average, Minimum, Maximum, Standard Deviation, or Variance (see Figure 9.2 for an explanation of these total types).

Selecting a Field to Total

After you have selected a total type, select a field to which you can apply the method of totaling you have selected. If you have selected Sum, Average, Deviation, or Variance, R&R lists only numeric and logical fields. Figure 9.3 shows the valid total type for each data type.

Data Type of Field Being Totaled	Valid Total Types
Numeric	Count, Sum, Average, Minimum, Maximum, Deviation, Variance
Character	Count, Minimum, Maximum
Date	Count, Minimum, Maximum
Logical	Count, Sum, Average, Minimum, Maximum, Variance, Deviation
Memo	None

Figure 9.3 Valid Total Types

Selecting a Reset Level

Next, select a total reset level (see Figure 9.4). Your choice determines when R&R resets the value of the total field to zero. If you reset on a group field, R&R will produce group subtotals. If you select Page Total, R&R will produce page subtotals. If you select Grand Total, R&R produces grand totals for the entire report.

For example, if STATE is your first group field, you can select 1) STATE from the Reset list box to calculate total sales by state. In this case, R&R produces a subtotal of sales and resets this subtotal to zero whenever a new state group begins.

Select	To Produce a
Grand Total	Total for the entire report
Page Total	Page total for each page in the report
Numbered Group Field	Subtotal for each new group

Figure 9.4 Total Reset Options

Creating Totals for Multiple Fields

You can select multiple fields on the layout and have R&R automatically create totals for those fields and insert the totals on a new band line.

To create totals for multiple fields:

1. Highlight all of the fields you want R&R to create totals for (Ctrl-click on each field).

2. Select Calculations ⟹ Auto Total to display the Auto Total dialog.

3. On the Auto Total dialog, select a total type and reset level for the totals to be created. Note that only total types valid for all selected fields are available for selection.

4. When you are finished defining the totals, select OK. R&R automatically assigns a name to each of the total fields in the batch. The name is in the form **Total*nnnnn***, where ***nnnnn*** is a number in the range 00001 to 99999 and is incremented by 1 for each total in the batch. (If necessary, you can change the field names individually later using the Calculations ⟹ Total Field Edit command.)

R&R creates the totals and inserts them in a band appropriate for the reset level you specified (Summary band for Grand totals, Page Footer for Page totals, and Group Footer for Group totals).

Editing Total Fields

To edit an existing total field, select Calculations ⟹ Total Field or the Total button. The Total Fields dialog (see Figure 9.5) displays the names of all existing total fields.
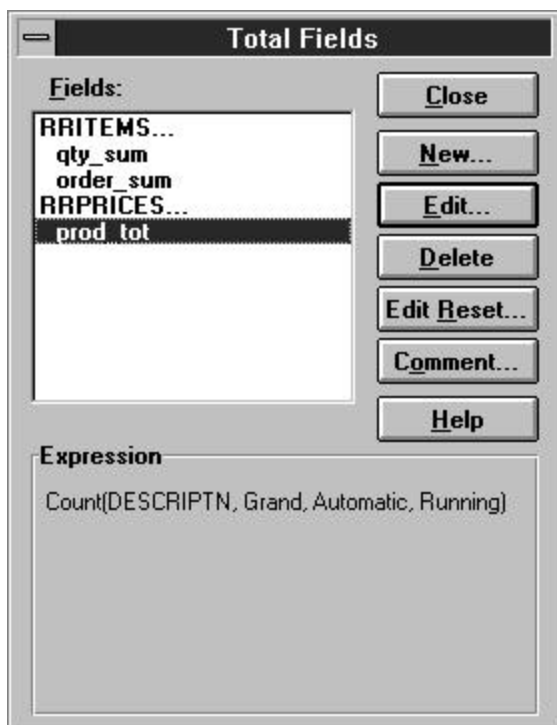
Figure 9.5 Total Fields Dialog Box

Select the field to be edited and select Edit to display the Edit Total dialog box; then follow these steps:

1. Optionally change the name.

2. As necessary, change the field to be totaled, the total type, and the reset level.

3. Select Options to change the accumulation frequency, select a processing option (Running or Pre-processed), or enter a condition expression.

4. When you have made all necessary changes to the total field, select OK on the Edit Total dialog; then select Close.

Note that you can select the Edit Reset button on the Total Fields dialog to change the reset level of all fields that reset at a particular level. For example, if you select "Page total" in the Change From box and "DESCRIPTN" in the Change To box on the Edit Reset dialog, all fields previously defined to reset at the end of each page would instead reset when the value of the DESCRIPTN field changed.

Deleting a Total Field

To delete a total field, in the Edit Total dialog box select the field to be deleted. Then select Delete. If you attempt to delete a field that is used in a calculation or total, R&R shows you a list of all fields that will be deleted as a result and asks you to confirm. You cannot delete any total field that is used as a linking field.

If you delete a total that is used in a query, you will have to edit the query.

Customizing Totals

When you create a total field, R&R automatically adopts a default method of accumulating the total value and a default mode of total processing. This default behavior is appropriate for most total values. However, you can select Options on the New/Edit Total dialog box to change this default behavior. The sections that follow explain how to change R&R's total accumulation frequency and total processing.

Selecting a Total Accumulation Frequency

When you create a total field, R&R automatically sets the accumulation frequency of the total according to the default rules defined in the next section. This accumulation frequency determines how often R&R adds to the total as the report is processed.

The accumulation frequency automatically set by R&R is appropriate for most commonly generated totals. However, the Accumulation setting (accessed by selecting Options on the Field Total dialog) gives you the flexibility to override the automatic frequency to handle special cases.

For example, in the report illustrated in Figure 9.6, you might want two different totals: a count of distinct products and a count of sales transactions. Counting the Product field will give you the total number of transactions. Using the automatic method of total accumulation described in the next section, R&R will add to the product count every time it reads a record, resulting in a count of five.

To get the first total, a count of distinct products sold, you can use the Accumulation setting to change the accumulation frequency of the Product count field. If PRODUCT is the first group field, you would set the accumulation frequency to 1)PRODUCT. Using this method of

accumulation frequency, R&R will add to the product count every time the value in the Product group field changes, resulting in a count of two.

Product	Quantity	Date
PC Com	10	01/02/95
PC Com	20	01/02/95
PC Com	5	01/25/95
PC Graphics	25	01/02/95
PC Graphics	10	01/30/95

Figure 9.6 Sample Report

To manually adjust a total field's accumulation frequency, select Options on the Field Total dialog box and then select a frequency from the Accumulation list box.

You can change the accumulation frequency to any of the following:

❑ Automatic — accumulates total as described in the next section

❑ Every composite — accumulates total once per composite record

❑ 1 through 8 — accumulates total once per selected group

❑ Once per page — accumulates total once per page

You can see what accumulation frequency is assigned to any total field inserted on the report by looking at the Expression that displays in the Total Fields dialog box or in the Field Properties window (press F4).

For example, the following Expression indicates that the total field provides a grand count of the PRODUCT field accumulated every time the value of the PRODUCT field changes:

        Count(PRODUCT,Grand,PRODUCT,Running)

Default Accumulation Frequency Rules

The frequency with which R&R accumulates any "Automatic" total is determined by the scan level associated with the total, where scan levels are defined as follows:

❑ Level 1 (the highest scan level) — the level of the master table and any tables in a lookup relation to the master table.

❑ Level 2 — the level of any table scanned by a table at level one and any table(s) in a lookup relation with this scanned table.

❑ Levels 3 through 99 (the lowest scan level) — levels defined as above, with the scan level of any table being one lower (that is, one number higher) than that of the table that scans it.

R&R adds to the value of a total field when it reads a new record from a table at the field's scan level, where the scan level associated with a field is defined as the scan level of the table containing the field being totaled. The report shown in Figure 9.14 illustrates this principle.

The report is a three-table report based on a scan from a customer table (scan level 1) to an orders table (scan level 2) and another scan from the orders table to an items table (scan level 3). The report contains grand counts of customer number (from the customer table), order number (from the order table), and number of items ordered (from the items table).

The customer number count in this report is at the first (highest) scan level and is therefore accumulated whenever a new record is read from the customer table. The order number count is at the second scan level and is therefore accumulated whenever a new record is read from the orders table. The item count is at the third (lowest) scan level and is therefore accumulated whenever a new record is read from the items table. (Note that totals at the lowest scan level accumulate most frequently, with each composite record.)

Grand Customer Number	Grand Customer Count	Order Number	Grand Order Count	Item #	Grand Item Count
10001	1	32201	1	903	1
10001	1	32201	1	901	2
10001	1	32209	2	910	3
10001	1	32209	2	901	4
10001	1	32210	3	903	5
10001	1	32210	3	906	6
10003	2	32202	4	901	7
10003	2	32202	4	907	8

Figure 9.7 Default Total Accumulation Frequency

These default rules for total accumulation apply to all total fields except for those that total other totals. These fields accumulate when the field being totaled resets.

Selecting a Processing Option

By default, R&R calculates the value of a total progressively, as each record contributing to the total is read. This default processing enables you to see the running value of the total at any point in the report. For example, you can create an invoice with a running total of line amounts by putting an invoice group total field on a Record line in the report.

However, R&R allows you to change this processing mode so that the total value is pre-processed — that is, the value is computed before the report records are output. This pre-processing mode enables you to have access to the final value of the total earlier than it would ordinarily be calculated. As a result, you can place such a total field anywhere in the report, even at the beginning. Any total field except those listed in the **Pre-Processing Restrictions** section in this chapter can be designated as pre-processed.

In order to change R&R's method of total processing for a given total field, select Options from the Field Total dialog box and then select a processing method:

❑ Running — R&R's default method of total processing, in which a total is calculated progressively as each record contributing to the total is read.

❑ Pre-processed — A method of calculating the value of a total field by performing a preliminary read-through of the data to accumulate totals designated as pre-processed.

You can see what processing mode is assigned to any total field by looking at the Expression that displays in the Total Fields dialog box or the Field Properties window. For example, the following Expression indicates that the field provides a pre-processed grand count of the CUST_NO field:

Count(CUST_NO,Grand,Auto,Pre-processed)

When to Use Pre-Processed Totals

You should specify that a total field be pre-processed in cases such as the following:

❑ Placing a grand total field in the Title band or a group total in a Group Header band of a report;

❑ Creating a calculated field such as a "percent-of-total" field that compares a value in each record to a final value based on all records in a group or report;

❑ Using a total field to sort a report;

❑   Querying on a total field.

For example, the report excerpt in Figure 9.8 illustrates the use of pre-processed totals in Group Headers, sorting, and calculated fields. This report contains two total fields that have been designated as pre-processed. The first field, PRODCNT, counts the number of orders for each product. This field is pre-processed so that it can appear in the Group Header ("There are PRODCNT orders for PRODUCT.").

The second field, PRODSUM, sums the number of units ordered for each product. This field is pre-processed so that it can appear in the Group Header ("A total of PRODSUM units were ordered."), be used to sort the report in descending order based on total number of units sold, and be used in the calculated field expression that produces the figures in the "Percent of Units Ordered" column on the report.

```
                    WEEKLY PRODUCT ORDER SUMMARY

     There are 10 orders for PC Database. A total of 315 units
     were ordered.

       Order Number        Quantity       Percent of Units Ordered
              32205             50                            15.9%
              32202             50                            15.9%
              32207             45                            14.3%
              32210             45                            14.3%
              32201             30                             9.5%
              32211             25                             7.9%
              32216             25                             7.9%
              32208             20                             6.3%
              32206             15                             4.8%
              32214             10                             3.2%


     There are 6 orders for PC Spreadsheet. A total of 90 units
     were ordered.

       Order Number        Quantity       Percent of Units Ordered
              32205             30                            33.3%
              32212             15                            16.7%
              32206             15                            16.7%
              32210             10                            11.1%
              32203             10                            11.1%
              32202             10                            11.1%
```

Figure 9.8 Sample Report Using Pre-Processed Totals

Note that defining pre-processed totals affects the performance of your report, since R&R must read through records twice: once to calculate pre-processed totals and once to perform other calculations (if any) and generate the report.

Pre-Processing Restrictions

Pre-processed totals are accumulated in a single preliminary pass through the data that, for reasons of performance, does not involve page formatting.

For this reason, the following types of total fields *cannot* be designated as pre-processed:

❑ Pagination-related totals — These totals include page totals, totals whose accumulation frequency has been set to once per page, and totals involving calculated fields that use the PAGENO( ) function. This restriction results from the exclusion of page formatting from the preliminary total evaluation process.

❑ Totals of certain pre-processed totals — These totals include any total-of-total fields where the total-of-total accumulates more frequently than the field being totaled resets (for example, a grand total, accumulating once per composite, of a pre-processed group one subtotal). This restriction results from the fact that pre-processed totals are evaluated in a single extra pass. For totals such as these to be pre-processed, two extra passes would be required: one for the first pre-processed total and another for the field that totals it.

❑ Totals that reset or accumulate on group fields that are themselves pre-processed totals (or calculated fields whose expressions include pre-processed totals). This restriction is also a result of the single pass used to accumulate pre-processed totals.

Entering a Condition Expression

For any total field, you can specify a *condition expression* that controls the circumstances in which R&R will calculate that total. To do so, you select Condition on the Total dialog and enter a valid expression to control the total field. Syntax for a condition expression is the same as that for R&R calculated field expressions.

To specify a conditional total, follow these steps:

1. On the New/Edit Total dialog select Condition to display the Total Condition dialog.

2. Enter the condition expression. You can build the expression by selecting from fields, operators, expressions, and UDFs.

3. When the expression is complete, select Verify to ensure that the syntax is correct; then select OK. The expression is displayed at the bottom left of the Total dialog.

For example, suppose you have a report that summarizes product sales. The report includes a QUANTITY field containing the number of items for each order. You can create a conditional total that provides the total number of items ordered for each product number. To create such a conditional total for items with product number 901, you would first create a total named Tot901 (for example) that is a Grand Sum of the QUANTITY field. You would then select Condition and enter the following condition expression:

PRODUCT_NO = "901"

You could then place the TOT901 field in the report's Summary area to provide a grand total of items ordered for that product code. You could create similar conditional total fields for all remaining product numbers.

To see whether a condition has been attached to a total field, look at the Expression description that displays in the Field Properties dialog and, when the field is highlighted, on the Status Bar. If a condition expression is attached to the field, the description includes the word "Conditional."

Adding a Field Comment

You can enter a brief comment (up to 99 characters) to serve as a "plain English" explanation of a total field. To do so, select Calculations $\Rightarrow$ Total Field, highlight the field name, and select Comment to display the Field Comment dialog. Enter the annotation in the Comment box and then select OK. When a total field has a comment attached to it, right-clicking in the Status Bar toggles between field name/expression and comment.

You can also enter or edit a field comment using the Field Properties dialog box.

Using Total Fields in Reports

After you define a total field, you can insert it on the report layout just like you insert any other field. Where you place a total field on your layout usually depends on the reset level you have selected.

To insert a total field, double-click, select Insert $\Rightarrow$ Field, or press F11. The Field list contains database, total, and calculated fields.

Since a total is calculated cumulatively, as each record contributing to the total is read, the total field's final value is not available until the last record being totaled has been read (unless you have defined the field as a pre-processed total).

For this reason, you typically place total fields on lines that correspond to their reset levels as follows:

❑ Place a group total on a Group Footer line of the same level as the total's reset level (for example, put a total that resets on ORDNO on a Group Footer line associated with the ORDNO field).

❑ Place a page total on a Page Footer line.

❑ Place a grand total on a Summary line.

Each of these placement options is explained in more detail in the following sections, along with the option of placing a total field so that you can see the progressive accumulation of its value.

Note that the Processing setting (accessed by selecting Options on the Field Total dialog box) allows you to create pre-processed totals that make a field's "final" value available for use earlier than it would ordinarily be calculated.

Inserting Group Totals

A group total field is typically placed on a Group Footer line defined at the same level as the field's reset level. For example, if you have selected a group field as the reset level for a total, you will usually place the total on a Group Footer line associated with the same field.

Figure 9.9 shows a report layout that contains a total of the AMOUNT field. The group field selected as the reset level for the total is CUST_NO. Each line marked 1GF-CUST_NO is a Group Footer line associated with CUST_NO. The second of these lines contains the total field selected to reset each time the value of CUST_NO changes.

Figure 9.9 Report Layout for Group Total

The layout in Figure 9.9 produces the report excerpt in Figure 9.10.

```
Customer          Item     Quantity          Amount
Joyce Adams       903            36        $216.00
                  901            24         $96.00

                  Customer Total:          $312.00

Fred Anderson     910            18        $162.00
                  902            12         $60.00
                  901            36        $144.00

                  Customer Total:          $366.00
```

Figure 9.10 Report with Group Totals

R&R produces a total for each new group of records, that is, every time the value of the CUST_NO field changes.

Inserting Page Totals

A page total field is typically placed in the Page Footer band so that it will print at the end of each page of a report. For example, Figure 9.11 shows the placement of the page sum of AMOUNT. Note that page totals of group totals include only groups that end on the page.

Figure 9.11 Report Layout for Page Total

The layout in Figure 9.11 produces the report excerpt shown in Figure 9.12.

```
Customer          Item     Quantity          Amount
Joyce Adams       903            36        $216.00
                  901            24         $96.00
                            .
                            .
                            .

Page 1                      Page Total:   $2,135.00
```

Figure 9.12 Report with Page Total

Inserting Grand Totals

A grand total field is typically placed at the end of a report, in the Summary band. For example, Figure 9.13 shows the placement of the grand sum of the AMOUNT field.

Figure 9.13 Report Layout for Grand Total

The layout in Figure 9.13 produces the report excerpt in Figure 9.14.

```
  Customer        Item    Quantity         Amount
  Joyce Adams     903           36        $216.00
                  901           24         $96.00
                              .
                              .
                              .
  Wanda Warner    910           18        $162.00
                  902           12         $60.00
                  901           36        $144.00

             Total for All Customers: $9,366.00
```

Figure 9.14 Report with Grand Total

Displaying Progressive Accumulation

You can also place total fields on lines where they will display the progressive accumulation of the total value as records, groups, or pages are processed. For example, you might create a total field with Grand Total as the reset level and place it on any Group Footer or Record line (placing it on a Record line will give you the maximum amount of detail). For example, Figure 9.15 shows the placement of a Grand Total field that accumulates the amount owed.

Figure 9.15   Report Layout for Progressive Total

The report layout shown in Figure 9.15 produces the report excerpt shown in Figure 9.16. Note that placing the total field on a Record line displays the progressive accumulation of the Grand Total as each record is printed.

```
 Customer            Amount Due          Total Owed
 Joyce Adams              $162                $162
                          $60                 $222
                          $144                $366
 Fred Anderson           $138                $504
                          $117                $621
                          $108                $729
                            .
```

Figure 9.16   Report with Progressive Total

Using Totals in Calculations

After you have created a total field, you can use it in calculated field expressions or create other totals based on it. For example, if you have created a total field, ORDERTOT, that sums the line items on an invoice, you could create a calculated field to compute a 5 percent sales tax. You could also create a Grand sum of the ORDERTOT field to calculate the value of all invoices generated as the report was run.

The sales tax calculation based on the ORDERTOT field would typically be placed in the ORDERNO Group Footer or, if each invoice were a separate page, in a Page Footer line.

If you want to perform calculations on the final value of a total field before this value would normally be calculated (for example, put the total amount of an invoice, along with its sales tax, in the invoice Group Header), change the Processing setting (accessed by selecting Options on the Total Field dialog box) to designate the total as a pre-processed total.

Sorting and Querying on Totals

In many cases, you can sort and query on total fields. The following sections explain how to use totals in sorting and querying and identify restrictions that R&R imposes in using totals in sorts and queries.

Sorting on Totals

You can sort on any total field that has been designated as pre-processed using the Processing setting on the New/Edit Total dialog. For example, to produce a report listing products in order of the total number of orders, you would first create a pre-processed order total field. Then, you would select the Sort button to specify the order total field as the first sort field. See Figure 9.8 for an example.

You can also sort on calculated fields whose expressions include pre-processed totals, unless the expressions also include table fields. For example, you can sort on a calculated field whose expression uses a pre-processed customer total field and a pre-processed order total field (e.g. ORD_TOT/CUST_TOT). However, you cannot sort on a calculated field that figures a percent-of-total by dividing a table field by a pre-processed total (e.g. ITEMCOST/ORD_TOT).

See Chapter 11, "Sorting and Grouping Data," for more information on sorting on pre-processed totals.

Querying on Totals

When you query on a total field (or on a calculated field whose expression includes a total field), records that do not satisfy the conditions established by the query will not contribute to the total. For this reason, total field queries may not select the records you expect unless you designate the total fields as pre-processed. For example, to print only those invoices for amounts over $1,000, make the invoice total pre-processed and define a query that selects all records in which the value in this total field is greater than 1,000.

Due to the nature of R&R's total processing, two restrictions apply to queries that use totals (see Chapter 12, "Creating Queries," for more information about querying on total fields):

❑ You can query on a pre-processed total only if no other pre-processed total is defined at a higher (more inclusive) reset level. For example, you cannot query on a pre-processed group total if the report contains pre-processed grand totals.

❑ You cannot query on running totals if your report contains any pre-processed totals.