Equations 3–46 and 3–47 are logically equivalent and can be considered the same as far as simplification is concerned since both equations are made up of three terms, each term containing two variables. Notice that combining 1-cells into adjacent groups of two produces terms that have only two variables. If, for example, we did not combine the 1-cells into groups, we would have to take each cell individually and would have the following logic equation

Equation (3–48)

$$P = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + \bar{A}BC + A\bar{B}\bar{C} + ABC$$

It is apparent that Equation 3–48 is unsimplified and is more complex than Equations 3–46 and 3–47 since it contains five terms, each term having three variables.

To further emphasize the importance of combining 1-cells into groups, let us obtain the equation for either of the K-maps in Figure 3–53 by *not* including cell no. 1 in any group

Equation (3–49)

$$P = \bar{B}\bar{C} + \bar{A}\bar{B}C + BC$$

Notice that Equation 3–49 is logically equivalent to Equations 3–46 and 3–47, but is more complex since it contains one term with three variables. We can prove that Equation 3–49 is not *completely* simplified by using Boolean algebra

$$P = \bar{B}\bar{C} + \bar{A}\bar{B}C + BC$$
$$P = \bar{B}(\bar{C} + \bar{A}C) + BC \qquad \text{(distributive)}$$
$$P = \bar{B}(\bar{C} + \bar{A}) + BC \qquad \text{(miscellaneous)}$$
$$P = \bar{B}\bar{C} + \bar{A}\bar{B} + BC \qquad \text{(distributive)}$$

Notice that the equation we have obtained is the same as Equation 3–46. We could also use a different approach to the Boolean simplification and obtain Equation 3–47

$$P = \bar{B}\bar{C} + \bar{A}\bar{B}C + BC$$
$$P = \bar{B}\bar{C} + C(\bar{A}\bar{B} + B) \qquad \text{(distributive)}$$
$$P = \bar{B}\bar{C} + C(\bar{A} + B) \qquad \text{(miscellaneous)}$$
$$P = \bar{B}\bar{C} + \bar{A}C + BC \qquad \text{(distributive)}$$

Therefore to obtain the simplest possible logic equation an attempt must be made to include a 1-cell in a group. 1-cells that are not adjacent to any other 1-cell must be taken alone (i.e., as minterms). However, all 1-cells must be accounted for in the final equation either as groups or taken individually. Overlapping groups are possible as can be seen in Figure 3–53a and b, but if all 1-cells have been accounted for either alone or in adjacent groups then it would not be appropriate to combine 1-cells into other groups again. For example, in Figure 3–53a combining cell no. 1 and cell no. 3 into *another* group would not be appropriate since these two cells have already been included in other groups; if we did combine these two cells again, the logic equation obtained (Equation 3–50) would have an extra term although it would be logically equivalent to Equation 3–46

Equation (3–50)

$$P = \bar{B}\bar{C} + \bar{A}\bar{B} + BC + \bar{A}C$$

It is possible for K-maps to have *four* adjacent cells containing 1's. Figure 3–54 shows such a K-map. Notice in Figure 3–54 that since cells nos. 1, 3, 7, and 5 are adjacent (in that order), only one variable, *R*,