4.4 EXAMPLE OF CUT SET IDENTIFICATION PROCEDURE

To illustrate the calculational methods used by MFAULT, an example is given using a branch of the sample fault tree (Section 2.4) shown in Figure 11.

By inspection the following cut sets are obtained:

X29 X30 X29 X29 X31
X29 X30 X31 X29 X31
X29 X30 X32 X29 X31
X29 X30 X29 X30
X29 X30 X31 X30
X29 X30 X32 X30
X29 X30 X29 X32
X29 X30 X31 X32
X29 X30 X32 X32

Further reduction of duplicate events within a cut set results in:

X29 X30 X31
X29 X30 X31
X29 X30 X31 X32
X29 X30
X29 X30 X31
X29 X30 X32
X29 X30 X32
X29 X30 X31 X32
X29 X30 X32

Elimination of duplicate cut sets gives:

X29 X30 X31
X29 X30 X31 X32
X29 X30
X29 X30 X32

Further reduction to minimal cut sets results in:

X29 X30

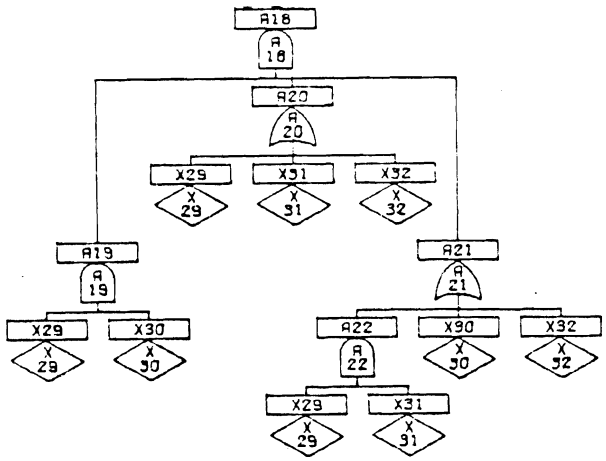

FIGURE 11. Example Fault Tree Branch

The procedures used by MFAULT to solve the above problem are outlined in this section. First the tree input is ordered and each gate and component (basic event) are given a cross reference index. The last reference for each gate is determined and the following ordered tree is obtained:

(2001)	A22	AND	(1) X29	(3) X31	
(2002)	A20	OR	(1) X29	(3) X31	(4) X32
(2003)	A19	AND	(1) X29	(2) X30	
(2004)	A21	OR	(2001) A22	(2) X30	(4) X32
(2005)	A18	AND	(2003) A19	(2002) A20	(2004) A21

TOP = (2005) A18

In this example, all gates below index 2003 are component only gates (only basic events are input) and are not processed until needed. Gate processing begins at gate 2004 (A21) and continues to the top of the tree.

Since gate A21 is an OR gate and has two components among its inputs, two cut sets of level one are produced:

X30
X32

The other input to gate A21 is gate A22 which is a component only AND gate. One additional cut set is produced:

X29 X31

If probability calculations are desired, they are done at this point and those cut sets less than the specified cutoff will be dropped. Also if additional previously defined gates had been input to gate A21, disk IDISK would have been searched for those gates and their corresponding cut sets and probabilities. These cut sets would be simply appended to the list of cut sets just calculated to complete the total list of cut sets for this gate.

All cut sets for A21 have now been identified and are written to disk NEWGT. NEWGT is read and the cut sets are ordered by increasing level. At this point, at the user's option, duplicate cut sets are eliminated from the NEWGT disk (subroutine WEED). Gate A21 and its ordered cut sets are appended to disk IDISC.

The next gate to be processed is gate A18. Inputs to gate A18 consist of gates A19, A20, and A21. Since gate A21 is a previously processed input gate, disk IDISK is searched to find gate A21 and its corresponding cut sets. The list of cut sets from gate A21 is written to disk IANDD. Since this is its last reference, A21 cut sets are not written to disk IDISC.* The component only input gates to gate A18 are processed next. The IANDAL table is constructed for gate A20.

	partial cut set number		
level	1	2	3
1	X29	X31	X32

Since gate A20 is an OR gate three partial cut sets of level one are produced. The final component only input gate to A18 is gate A19. Gate A19 is a component only AND gate. One cut set is produced:

X29 X30

This cut set is logically combined with the existing partial cut sets in the IANDAL table and results in:

	partial cut set number		
level	1	2	3
1	X29	X31	X32
2	X29	X29	X29
3	X30	X30	X30

At this point all partial cut sets from disk IANDD and the IANDAL table are logically combined to obtain the cut sets from gate A18.

*For the more general case for a particular gate, disk IDISK is searched to find the previously processed input gates of interest. If not the last reference, the input gate and its cut sets are written to disk IDISC. If it is the first previously processed input gate, the input gate and its cut sets are written to disk IANDD. Additional previously processed input gates are written to disk JANDD.

The ordering of components and checking for duplicate components within a cut set are the next operations performed. As each cut set is generated, its indices are placed into an array (ICINDX) which initially contains all zero values. Nonzero positions now correspond to the component indices. Since all duplicate components are placed in the same position, the duplicate component reduction is automatic. The nonzero locations of the array are then checked to generate the ordered cut set. The cut set level is determined by simply counting the nonzero values. The cut sets are written to disk NEWGT. The cut sets for gate A18 are shown below:

```
X29  X30
X29  X30  X31
X29  X30  X32
X29  X30  X32
X29  X30  X31  X32
X29  X30  X32
X29  X30  X31
X29  X30  X31
X29  X30  X31  X32
```

If the probability calculations are desired, they are done at this point and those cut sets less than the specified cutoff will be dropped.

The next step is to arrange the cut sets in ascending order and to eliminate duplicate cut sets, at the user's option. Disk NEWGT is read and the cut sets are ordered by increasing level. At this point, duplicate cut sets are eliminated from the NEWGT disk (subroutine WEED). This results in the following cut sets which are written to disk IDISC.

```
X29  X30
X29  X30  X31
X29  X30  X32
X29  X30  X31  X32
```

The final step in the cut set calculation is the reduction to minimal cut sets (user's option). These operations are performed by the subroutine MINIMAL. For gate A18 one cut set is output:

X29 X30