

MSC22-C. Use the `setjmp()`, `longjmp()` facility securely

The `setjmp()` macro should be invoked from only one of the contexts listed in subclause 7.13.1.1 of the C Standard [ISO/IEC 9899:2011]. Invoking `setjmp()` outside of one of these contexts results in [undefined behavior](#). (See [undefined behavior 125](#).)

After invoking `longjmp()`, non-volatile-qualified local objects should not be accessed if their values could have changed since the invocation of `setjmp()`. Their value in this case is considered [indeterminate](#), and accessing them is undefined behavior. (See [undefined behaviors 127](#) and [10](#).)

The `longjmp()` function should never be used to return control to a function that has terminated execution. (See [undefined behavior 126](#).)

Signal masks, floating-point status flags, and the state of open files are *not* saved by the `setjmp()` function. If signal masks need to be saved, the POSIX `sigsetjmp()` function should be used.

This recommendation is related to [SIG30-C. Call only asynchronous-safe functions within signal handlers](#) and [ENV32-C. All exit handlers must return normally](#).

Noncompliant Code Example

This noncompliant code example calls `setjmp()` in an assignment statement, resulting in [undefined behavior](#):

```
jmp_buf buf;

void f(void) {
    int i = setjmp(buf);
    if (i == 0) {
        g();
    } else {
        /* longjmp was invoked */
    }
}

void g(void) {
    /* ... */
    longjmp(buf, 1);
}
```

Compliant Solution

Placing the call to `setjmp()` in the `if` statement and, optionally, comparing it with a constant integer removes the undefined behavior, as shown in this compliant solution:

```
jmp_buf buf;

void f(void) {
    if (setjmp(buf) == 0) {
        g();
    } else {
        /* longjmp was invoked */
    }
}

void g(void) {
    /* ... */
    longjmp(buf, 1);
}
```

Noncompliant Code Example

Any attempt to invoke the `longjmp()` function to transfer control to a function that has completed execution results in [undefined behavior](#):

```

jmp_buf buf;
unsigned char b[] = {0xe5, 0x06, 0x40, 0x00, 0x00, 0x00, 0x00, 0x00};

int main(void) {
    setup();
    do_stuff();
    return 0;
}

void setup(void) {
    f();
}

void f(void) {
    g();
}

void g(void) {
    if (setjmp(buf) == 0) {
        printf("setjmp() invoked\n");
    } else {
        printf("longjmp() invoked\n");
    }
}

void do_stuff(void) {
    char a[8];
    memcpy(a, b, 8);
    /* ... */
    longjmp(buf, 1);
}

void bad(void) {
    printf("Should not be called!\n");
    exit(1);
}

```

Implementation Details

Compiled for x86-64 using GCC 4.1.2 on Linux, the preceding example outputs the following when run:

```

setjmp() invoked
longjmp() invoked
Should not be called!

```

Because `g()` has finished executing at the time `longjmp()` is called, it is no longer on the stack. When `do_stuff()` is invoked, its stack frame occupies the same memory as the old stack frame of `g()`. In this case, `a` was located in the same location as the return address of function `g()`. The call to `memcpy()` overwrites the return address, so when `longjmp()` sends control back to function `g()`, the function returns to the wrong address (in this case, to function `bad()`).

If the array `b` were user specified, the user would be able to set the return address of function `g()` to any location.

Compliant Solution

The `longjmp()` function should be used only when the function containing the corresponding `setjmp()` is guaranteed not to have completed execution, as in the following example:

```

jmp_buf buf;
unsigned char b[] = {0xe5, 0x06, 0x40, 0x00, 0x00, 0x00, 0x00, 0x00};

int main(void) {
    if (setjmp(buf) == 0) {
        printf("setjmp() invoked\n");
    } else {
        printf("longjmp() invoked\n");
    }
    do_stuff();
    return 0;
}

void do_stuff(void) {
    char a[8];
    memcpy(a, b, 8);
    /* ... */
    longjmp(buf, 1);
}

void bad(void) {
    printf("Should not be called!\n");
    exit(1);
}

```

There is no risk of overwriting a return address because the stack frame of `main()` (the function that invoked `setjmp()`) is still on the stack; so when `do_stuff()` is invoked, the two stack frames will not overlap.

Noncompliant Code Example

In this noncompliant example, non-volatile-qualified objects local to the function that invoked the corresponding `setjmp()` have [indeterminate values](#) after `longjmp()` is executed if their value has been changed since the invocation of `setjmp()`:

```

jmp_buf buf;

void f(void) {
    int i = 0;
    if (setjmp(buf) != 0) {
        printf("%i\n", i);
        /* ... */
    }
    i = 2;
    g();
}

void g(void) {
    /* ... */
    longjmp(buf, 1);
}

```

Compliant Solution

If an object local to the function that invoked `setjmp()` needs to be accessed after `longjmp()` returns control to the function, the object should be volatile-qualified:

```

jmp_buf buf;

void f(void) {
    volatile int i = 0;
    if (setjmp(buf) != 0) {
        printf("%i\n", i);
        /* ... */
    }
    i = 2;
    g();
}

void g(void) {
    /* ... */
    longjmp(buf, 1);
}

```

Risk Assessment

Recommendation	Severity	Likelihood	Remediation Cost	Priority	Level
MSC22-C	Low	Probable	Medium	P4	L3

Automated Detection

Tool	Version	Checker	Description
CodeSonar	6.0p0	BADFUNC.LONGJMP	Use of longjmp
		BADFUNC.SETJMP	Use of setjmp
LDRA tool suite	9.7.1	43 S	Enhanced enforcement
Parasoft C/C++test	2021.1	CERT_C-MS22-a	The setjmp macro and the longjmp function shall not be used
Polyspace Bug Finder	R2021a	CERT C: Rec. MSC22-C	Checks for use of setjmp/longjmp (rec. fully covered)
SonarQube C/C++ Plugin	3.11	S982	

