

The ICs that entered the shelf life program were of WR quality and were selected from production lots also used for WR system deliveries. Therefore, the shelf life program ICs were completely representative of the ICs that were assembled in W88 electronic assemblies. The availability of each IC type varied due to production schedules during each year of the shelf life program, so the quantities of each type were not all equal at the end of the program.

The IC storage environments were chosen to be similar to that experienced in the Trident II application. Unpowered storage in both room temperature and +125 °C (the high temperature of the IC test specification) ambients simulated the use conditions reasonably well and were relatively easy to implement. Prior to being put into the storage environment, the ICs were subjected to a brief dynamic screen to simulate the War Reserve (WR) component manufacturing and acceptance process. Calculations by W. M. Miller, manager of SNL Reliability Physics Department 1276, indicated that subjecting the ICs to the dynamic screen environment (being used in production at that time for certain types of ICs) for 7 hours would simulate the manufacturing and acceptance conditions experienced by WR ICs. Following the dynamic screen, the ICs were electrically retested before entering the storage phase of the shelf life program.

The major goals of the program were accomplished through annual electrical testing of the stored ICs and Destructive Physical Analysis (DPA) of selected ICs from those in storage. ICs that failed electrical test requirements or DPA criteria were analyzed. Table 1 summarizes the information for the ICs that started into the program. A more detailed list of these is provided in the appendix.

Table 1
Information for ICs Starting the Program

W88 Subassembly	IC Type	IC Function	Year Started	# ICs Started
MC3811 Programmer	SA2998	1K MNOS RAM	1989	19
			1990	20
			1992	20
MC3811 Programmer	SA3000	SNL/AMO μ P	1989	20
MC3811 Programmer	SA3601	Harris μ P	1992	18
			1993	40
MC3811 Programmer	SA3001	2K SRAM	1989	20
			1993	20
MC3813 Force Balance Integrating Accelerometer	SA3230	A/D Converter	1989	18
			1990	20
			1991	20
MC3827 Clock	SA3246	Clock Counter	1989	17
			1990	20
Total				272

previously investigated and determined to present acceptable risk. The current reliability assessment of the W88 stockpile assemblies employing these and related ICs is reinforced by the results of this shelf life program. It is also very important to observe that there have been no known failures of these ICs in any WR stockpile assembly. This is particularly significant for the W88, since each MC3811 programmer in the active stockpile is operated several times each year.

The remaining shelf life program ICs will be retained as a unique and valuable resource for future stockpile evaluation and failure analysis efforts. The 211 ICs remaining at the end of this program will be retained by the SNL Failure Analysis Department to support WR stockpile evaluation activities.

The following is a recommendation that results from this program.

Data from the W88 Integrated Circuit Shelf Life Program will be helpful for any future investigation of the failure modes of the 4/3 micron or MNOS IC technologies. The investigation of any failure or abnormal behavior of any W88 or other WR assembly IC from the 4/3 micron (Harris or SNL/AMO) or MNOS technologies should include a determination of whether such behavior involves the failure modes and mechanisms evaluated in the shelf life program. This includes the 4/3 snapback, MNOS oxide breakdown, and bond wire strength and clearance issues as described in this report. Although it is not expected, if evidence is found during stockpile testing or other activities of occurrences that relate to the shelf life program observations, then it is highly recommended that the reliability estimate for WR assemblies that contain these ICs be carefully reevaluated.