SATURN LAUNCH VEHICLE ENGINE MATURITY FACTORS*

ENGINE	TOTAL DELIVERED	TOTAL TEST TIME	TOTAL FLIGHT TIME
H-1	262	483,233 SEC	13,323 SEC
J-2	100	273,903 SEC	1,185 SEC
F-1	54	167,035 SEC	0

*AS OF FEB. 1, 1967 IND B1488B

FIGURE 40

States. Another typical example is the problem experienced on the uprated Saturn I AS–208 first stage. During static test at Marshall a few months ago, an H–1 engine turbine wheel failed. The blades actually left the turbine wheel (fig. 41). Subsequent investigation showed that we had human error in the manufacturing process. Figure 42 represents the turbine wheel blade production procedure and illustrates from point 1 to 14 turbine wheel manufacturing and assembly. The majority of the turbine wheel blades for rocket engines, including DOD rocket engines and jet engines, are manufactured in Kokomo, Ind., by Haynes Stellite Division of Union Carbide.

The basic manufacturing process is to take bar stock and form it into BB-size pellets which are weighed, placed in storage cans and delivered to multi-bin storage for use in blade manufacture. Unfortunately, employees seeking pellets for casting turbine wheel blades drew material from the wrong storage bin. These blades were ultimately delivered to Rocketdyne where they were assembled into turbine wheels.

Approximately 260 turbine wheel blades were manufactured from the wrong material, stainless steel. However, it is important to note that all of the blades and the wheels to which they were attached have been located, except for those which were scrapped. The system has been purged of this particular malady.

The importance is not that we lost the turbine wheel of course, but with the thousands of people in the United States who are working on the program, this is the kind of thing that can happen. The challenge is the prevention of problems of this sort.

I mentioned earlier the J–2 engine restart requirement and the reason for this requirement (fig. 43). We found on Uprated Saturn I