

## THE BENDIX EXPERIENCE

*As recalled by Doug Feldwick, in April 2002.*

I have to think back to Christmas 1948 for my beginning with Bendix Radio. Because of its importance to me at the time, a personal note is in order. My wife and I, and our two infant sons, were newly arrived as immigrants from England and, if we were going to be able to stay, our first consideration had to be finding work. In those days the Immigration laws were such that one was not permitted to have a job already lined up before coming to America. This was to prevent unfair competition against the U.S. Military Service men returning from WW2. Being a returning U.K. Military Service man didn't count. In any case I didn't know anyone to contact.

I made my first visit to Bendix Radio on Joppa Road during those usually dead few days between Christmas and the New Year. Ed White took me in with him when he went to work. The Personnel department solved our urgent need by arranging interviews for me with various departments, one of which was with Bob Davis, the chief engineer of a Radar design group. My previous work in the telephone business exactly matched his needs on the FPS-3 project. What a happy coincidence ! I had a job as a technician, starting January 10, 1949. This was less than a month since stepping off the Queen Mary in New York and one of the better moves I have made in my life !

I didn't have the security clearance necessary for work on that project so until one could be obtained Bob took me to see George Vacek, the chief foreman of the factory Test department, where I was to make myself useful and learn the ways of Bendix. George agreed to put me to work in the Transmitter Test area, which was where the larger production units were handled. There I met Les Darrel who, at the time, was ringing out wiring continuity in a big "black box"; a part of the MPN-1 system. When that was finished he involved me in the measurement of the impedance of endless quantities of the cable assembly that connects the antenna of the Bendix Radio Compass to its ARN-6 receiver. There was a tedious calculation to be done on each cable and I think Les was glad to have someone to do it. Every D.C. 3 plane I ever saw had one of these antennas perched on top of the fuselage. The next job was the composite testing of several consoles of Bendix-made transmitters and receivers, destined for Argentina. And then the "knifing" of 4-gang variable capacitors, and so on.....

Anything that did not pass any of these tests had to be trouble-shot by the testers and repaired by Donald Crumm, the area mechanic. Generally there was always something going on, although sometimes there was a gap between jobs that enabled us to fiddle around with the remnants of old equipments that were stashed in cardboard boxes in the cupboards that housed the test equipment. Except for building a crystal/catwhisker set as a juvenile, and a one-tube TRF set at school, Bendix was my first real contact with anything to do with radio. An ARRL handbook and the use of Don's tools helped me to make a frequency converter that would tune the B.B.C. programs. They came from a wire antenna stretched from the test department's window up to the top of the machine shop on the hill. The resulting signal energized a wire loop placed near the antenna coil of Don's broadcast receiver. I used to shift his tuning away from the Paul Harvey program and I sometimes forgot to put it back. The test equipment; Q-meters, signal generators, secondary standard resistors and capacitors and the like all played a part in this fun-stuff. These also had to be recalibrated at specific intervals by the Measurements and Standards section of Quality Control.

The Manager of all of the various Quality Control departments was Henry Newton. He had an office that was reached from the mezzanine floor along which the radios for Ford automobiles were built. They were made on a moving belt, as in the Lucille Ball skit, where about fifty females sat on (or overflowed) wrought iron stools, each doing their own little bits of assembly. I still have one of those stools which I bought as a memento when the line eventually shut down. All of us Towson old-timers had a sentimental attachment to the stools, they sold like hot cakes. Also in the Q.C. office there was an elaborate series of racks of frequency generators. Their outputs were constantly monitored against the National Bureau of Standards and distributed throughout the plant as needed for precision alignments.

In letters from my father and relatives back in England I heard that the F.B.I. had been investigating my background, both militarily, socially and as an engineer in the telephone service. This led to the granting of the needed security clearance. Now I could enter the hallowed ground of Bob Davis' Dept 63. As a technician I would work for project engineer Bill Garbutt.

I am sure that it was my first task in this 63 lab that has to be credited with the support I enjoyed from Bob Davis throughout my entire career with Bendix. I made a rotary switch for Jack Best to take to a sub-contractor the next week to test the first controller of the huge electric motor that rotates the F P S-3 antenna. Its function was to select the four rotation speeds, but only from slow up to fast and not in reverse, when inertia could send the whole antenna tumbling off its tower. I made a ratchet wheel and pawl, such as are used on automatic telephone switches, and sandwiched it between two end plates of an Oak switch so that it could only be turned in one direction.

I went on to assist Bill Garbutt in the design and making of the first Control cabinet for the FPS-3 radar, and with the construction of the cables that interconnect the many cabinets throughout the radar Operations Shelter building. Some of the special tools that I made to fabricate the cables went on to be copied for the factory production.

Bill was also the cognizant engineer for the subcontracted telephone system AN/GTA-3 which communicated between radar scopes and with the outside world. This was the kind of work which Bob Davis had in mind for me when he hired me. I became resident at the Connecticut Telephone Company, the subcontractors, in Meriden CT. Already familiar with the various types of telephone equipment, this was an easy task for me. One of the people who also made frequent visits to this plant was the U.S. government design engineer for the GTA-3 System. It turned out that he knew the old telephone exchange in London where I had worked as a youth. It had been installed by an American company, ATM. We would talk about the old days of telephony and we established a quite useful rapport. It led to my being the representative who could sign off on the acceptance of the equipments for Bendix and present them for Government acceptance. An unexpected outcome of this was that it was beyond the responsibility that Bendix management allowed to a Technician. Consequently in September 1950 I got a new title of Q.C. Field Inspector. And a raise.

Once all of the telephone sets had been made and shipped I was available for new work. By now I was the "property" of Henry Newton's Q.C. organization. So from April 1951 until October of 1952 he made me a foreman of the production testers who did the acceptance tests on units of the FPS-3. Then later, foreman in the Bendix plant at Harbour Field on units of the CPN18 radar. Included in these tests were the so-called "Type Tests", which used the huge walk-in climate rooms at Towson to verify the endurance of the equipment (and of the test personnel) in temperature extremes. Sometimes creative report writing was required to explain

malfunctions in the equipments under test, and what had been done to show that they were only the result of the normal fallout of JAN approved components.

One of the responsibilities of a test foreman is the “sell-off” of completed units to one of the resident Government Q.C. representatives. Except for their boss, Bill Bryson, and one other, they had varying degrees of understanding of the newer kinds of electronic test equipment. To get government acceptance of equipments it would be a matter of the government man sitting beside the Bendix tester while the tests were slowly repeated for his benefit so that he could verify the entries made on the Test Data sheets.

While down at Harbour Field I had noticed that the switch in the remote dial-up control of the C P N -18 was often out of adjustment by the time it had been installed. It was a type of telephone stepping switch of which I had, in my time, adjusted thousands. I wrote an adjustment procedure for it, ordered the tools necessary to do it and sent in a suggestion that this be included in the Test Specification. The letter came to the attention of one Dick Whiffen, who was supervisor of the Test and Inspection Engineers, Dept 49. It resulted in my being changed from a test foreman to a T & I Engineer, working in Towson for him. Starting from October, 1952 until March, 1956 my work consisted of preparing test Plans, specifications and testing procedures for the FPS 3A, MPS-7, FPS-20, APA-69 and providing test liaison for production of the FPS-14 and FPS-20 at the Harbour Field plant.

Test procedures and performance limits are required for each of the major assemblies of a system .They are manufactured and checked separately before being installed into their places. For example consider the FPS-3. There are: the antenna horn, the waveguide sections, the directional coupler, the signal mixer and so on down to the presentation of a blip on a P.P.I.

Or on an A-Scope up on the tower. Or, for that matter, testing the safety switches at the top of the ladder that opens on to the tower deck. In the Operations Shelter, the receiver cabinet has a continuity check and each of its gozinters are tested separately. The 30 Mhz receiver drawer, the MTI receiver, the mercury delay line, the comparator drawer, and the separate power supply drawers for each of them; they all have test data sheets to be filled out in accordance with written procedures Likewise, the CRT chassis in the PPI and its cabinet and its power supply. And the Range Mark generator and its cabinet and its power supply drawer. What have I missed? Oh yes; the Stalo has a rigorous stability check. How about the coffee pot ? When these are all put together, the System Check takes most of a day to do. All of this with detailed written instructions and data sheets to be filled out.

How does the T & I Engineer get all the necessary information to write them? Why, he bothers the design engineers of course! Jack Best for Antenna stuff , Russ Leister for directional coupler, etc., John Bachman for MTI , someone else for the receiver, Bill Garbut for the control cabinet. What are the input voltages, the output voltages under what dummy load conditions? What frequencies? What connection devices ? Special test equipment ?

Having these separate test procedures were invaluable for selling spare parts later. Orders came in many years after the radars were shipped; particularly for such things as the crystal mixer, a “plumber’s nightmare” that housed a signal diode and a mixer diode in a coaxial array of arms and legs. And the big butterfly capacitor for the MPN-1 nodding antenna. And anything else that fitted the Navy’s motto: “When our stock gets down to four, now’s the time to order more.”

For a while, Henry Newton had a second in command in his Quality Control Office named Gordon Badger, who used to make periodic visits to the testing areas; mainly for chats about how things were going. One day in 1955 I told him of a predicament that I had got myself into. I had applied for the forms necessary to become a citizen of the United States. They were delivered to my home the next Thursday afternoon with the information that I should attend the next citizenship examination. Surprise! ... It would be on the following Monday! Apart from having to learn about the Constitution of the U.S. in a hurry, I had also to bring a sponsor who could vouch for me. It could not be a relative. My predicament was that I could not think of anyone to ask who, on short notice, could afford to take the time off to come downtown with me on the Monday. Immediately, Gordon volunteered to do it. What's more, he treated me to lunch when it was all done.

With the departure of Dick Whiffin for another Division of Bendix I took his place as the supervisor of the T & I engineering group. But not for long. The then Director of Engineering, C.G.McMullen, pulled the first of his many spot assignments for me. He asked that I find out why the Talos Control Package Modules were in trouble and could not be shipped. It took only a few days to find out that they would only work properly if specially selected, favorable, vacuum tubes were installed. As a result of my report he gave me the job of heading a Project Manager type of arrangement, responsible for design engineering, etc, of the Talos type IV modules from prototype production to quantity factory production. Between the engineers at the Bendix Mischawaka plant and our engineer, Brantly Wall, at Towson, some necessary hardware changes were made and the production was resumed.

This became the pattern for much of the rest of my time with Bendix Radio. Namely intermittent tours of duty in Quality Control, interspersed with temporary detachments to tackle difficulties with production or to deal with other special assignments that didn't fit any particular job description. From May, 1959, I gained a title of "Principal Engineer" to cover all of the departmental hops, supplemented later by such exotic variations as; Staff, Senior, Supervisory and the like.

One example of these side trips, from October, 1960 until April, 1961, was the analysis of the engineering, production and test difficulties with the TSEC/KG-3 equipment. During the pre-test "burn-in" the units would go into an alarm mode and stop. Along with the design engineer Tom Murray, I spent countless hours outside a temperature test oven watching the units fail with no clear idea of why. It was Tom's idea of counting the number of trigger pulses occurring before the units stopped that gave the clue. It could be predicted that, if it would happen at all, it would be after a specific number of pulses. He reasoned that, with a particular test card pattern, a large number of flip-flop modules were being called upon to change state at the same time, resulting in a hefty current induction in wiring that ran in the same bunch as other wires that led to modules that were supposed not to change. I think that Bruce Watkins of the Test Equipment department had sensed the possibility of future trouble of this kind when he campaigned for a change to using pulse-steered flip-flop modules. This was long before the trouble actually hit, but he got a very small audience at the time. Additionally, to further complicate the analysis, there had been a change in the supply source for 2N404 transistors; the new supply had excessive stored base charge, a feature not controlled by their specification. It made them prone to unexpected switching. A change to the module design and new buy of transistors were decided upon to get things moving again. My contribution to correcting the

trouble was ordering the shielded wire to be used in strategic places. Also I have to own up to the fact that it was I who chose that ghastly pink color to be used to distinguish new-generation flip-flops from the old green ones. But a very effective tool for Configuration Control.

In March 1961, I took over the TSEC engineering group when Don Ordun left Bendix to form his own company. We had a fairly quiet time for over four years, releasing large quantities of these and like equipments for production. I got fairly expert in answering the NSA's questions as to what the costs would be for various other configurations that they would like to have. They usually bought.

In October, 1965, Bendix succeeded in becoming a sub-contractor to Douglas Aircraft for communications in the A/RIA space program. To implement part of their program I went back to test planning, using some of our own personnel but hiring additional contract people whom Douglas said that we needed. They were right! An utterly gigantic paper mill was written, most of which was ignored in the final analysis except that it provided sufficient paper on which to write the test results.

With A/RIA successfully behind us, I became a Staff Assistant to the new Manager of Quality Control, T.J. Cartin. Soon I went down to the Broening Highway plant daily to find out why the production of WRR-3 and WRC-1 equipments was in difficulty. The electrical tests showed that none of the units was passing the performance specifications. There were daily meetings with production, Q.C. and engineering, all of which tried to ignore the situation, blaming the testing procedures. The new General Manager, Al. Clark, was present at one of the meetings and I am told that afterwards he had asked who was that guy who smoked a pipe and was so outspoken. Eventually my assessment of the true situation was recognized; Bendix had been given a set of "build-to" drawings that could not produce satisfactory units. One of our Bendix design engineers, Art Williams, got the job of redesigning them. Bendix made a claim against the U.S. Navy for having entered into a contract with us which used a set of faulty drawings. Much time was spent in preparing evidence. It was resolved in our favor to the tune of \$7,600,000; not nearly enough in my opinion. In 1972 it was decided that the last of these systems would be built in Lee Blades' assembly area. Everything was brought up to Towson, including a lot of partly built, partly defective, and incomplete units. As a sideline to other things that I was doing, I spent some time helping the material control people decide on what missing parts to order and what of the previously rejected material was fit to be inspected, re-worked and used. Lee had a very determined repair man working for him; I wish I could remember his name; much credit is due to him and his crew. At the end of the contract I organized a thankful ceremony to say "goodbye WRC-1", with Al Clark driving the nails in the last shipping crate. See picture in the Bendix Beam, July 10, 1973.

In October 1971 a new department was formed which scooped up all of the various engineering and lab. technicians who, until then, had worked individually in the separate engineering departments. They were now given their own department number, 470. . Jim Stephenson had the group, which was called Equipment Support and I became the "Supervisory Engineer" of it. It turned out to be a kind of clearing house for moving technicians from a job that was ending to one that due to start. Some progress was made towards smoothing out inequities.

There was time left over from administering the technician pool for me to work on more of those odds-and-ends jobs. Such as a Value Engineering study of the SAM-D missile electronics. And a month-long excursion to Broening once more, this time to find out why the COMSEC Key generator units were failing in the temperature test. It was said that the trouble lay in the test equipment so I started an elaborate cross-check of it, only to conclude that this was not so. Hudson Keithley found the real cause; failure of a particular brand of electrolytic capacitors used in the KY units.

In August, 1975, I joined the Air Traffic Control engineering group, then under Joe McCormick until he became General Manager. When that happened, Joe Skudrna's took over the group. At this time the engineering lab was building some development models of the RT-1156, a part of the APX-100 Transponder. The contract required a number of so-called data items, one of which was a Technical Manual. I relied on the good offices of Jack Shaul and Ron Nickles and others to educate me enough about the equipment so that I could write the manual. I remember that the contents had to include a listing of the test equipment needed to service it and that this list had to be chosen from test equipments already in government inventory. In inventory was a Transponder Test Set; a UPM- something or other, the description of which looked ideal but which in reality was not. None of the three that were on government loan to us for the contract could measure some of the pulse characteristics. Knowing of this deficiency, the government representative agreed to my including a Tektronix oscilloscope in the list. Both he and we were hoping that by highlighting it's deficiencies the UPM would be improved and I think that Bendix eventually did win a proposal to do so.

There were other data items required, none of which made much sense but which were deliverable contract items. They had to be written in compliance with specified government directives as to format, pagination, chapter and verse. If one followed these you were assured of having them approved. During the scheduled annual vacation that year I stayed in the office for a couple of weeks while all was quiet and had these annoying things done and out of the way by the time Joe came back. Then I took my vacation.

I did a couple more sideline activities, such as working on the VINSON bid, before beginning my last assignment before retirement. This started as supervising the print room operations and the Release & Records department. The latter included assisting in the development of computer programs that would take the place of the old manually typing of Ditto masters of the top-down-breakdown listing of drawings, etc. In the early stages not all of the programs produced the desired results, which led to my epic comment that we might do better with green eye-shades and quill pens. (See: *The Communicator*, Volume XV. June 1979) Eventually there was a workable system and Helen Smith led the members of the release and records staff in the preparation of punched card inputs to the Production and Material Management system (PAMM). To lend a little relief to the tedious reading of Bills of Materials on the drawings, and the punching of IBM cards, I convened daily half-hour meetings around a table in my office. There we opened up a physical sample of an APM-378 and unplugged its various sub-assemblies so that they could see in the actual hardware the kind of things that they were doing. These meetings led to the formation of "Dougie's Angels".

About this time all of the new government contracts began to include military specifications governing control of the configuration of equipments as shipped.. Actually Bendix

had always had very strict controls of changes to drawings that delineated what was to be built. There was a completely satisfactory system of paper-shuffling on which to secure authorized agreements as to how and when changes were to become effective. I had dealt with it for years because changes to Test specifications used the same procedures. Who then better to write the newly required Configuration Control Manual for our division of Bendix. And who to serve as the first Configuration Control Chairman ?

In May, 1979, we had a wonderful retirement party over at Martin's East, celebrating thirty plus years of a very satisfactory career. There was never a dull moment with Bendix or Allied Signal or whatever they chose to call us. And always with the most pleasant of people; I only exploded twice the whole time I was there. About these I never tell; I wonder who remembers.