

## Reflections on the 15-ft Bubble Chamber

I.

**Robert R. Wilson**

*(Professor Emeritus, Cornell University, and Director of Fermilab from its inception until 1978)*

We had many exciting adventures in the course of building Fermilab. One of these involved the construction and use of the 15-ft Bubble Chamber, and now, as it reaches retirement, we can review that construction and use, we can celebrate its accomplishments, we can sentimentalize, perhaps we may even learn something of value for future projects of this kind. My recollections will be confined to how we came to build the 15-ft Bubble Chamber.

Now, the Berkeley Design Report for the 200-BeV Proton Accelerator had included some \$60 million which, among other things, envisioned one  $2\text{m}^3$ , and one  $100\text{m}^3$ , and one large borrowed bubble chamber. When the scope of the project was drastically reduced, these were all thrown out of the authorization plan along with the reduction of machine intensity and the scope of the experimental areas. Of course, the elimination of the funding for the bubble chambers did not eliminate the need for them.

I can't say that I was an aficionado of bubble chambers, quite to the contrary. Still, I had been deeply impressed by what the Alvarez group at Berkeley had accomplished, and bubble chambers did seem to be the ideal instrument for a preliminary investigation of the new energy range we would be exploring at Fermilab. More importantly, the experimenters who would use the accelerator made it very clear that a large bubble chamber should be one of the necessary facilities of the project. When the first Aspen Summer Study in 1968 had finished, there had been a general agreement that a 25-ft bubble chamber would be required to do the job. The Brookhaven National Laboratory (BNL) physicists volunteered to design it along the lines of the 7-ft Bubble Chamber which was just moving into the last stages of construction at BNL. Their efforts resulted in an elegant design (the 25-ft Bubble Chamber, October 1969). Alas, the proposal was turned down with a finality that precluded any future appeal.

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Perhaps the Atomic Energy Commission (AEC) was so obdurate because its volume was more than twice that envisaged in the Berkeley Study, or perhaps it was because the estimated cost of the chamber (\$15 million) seemed then to be so terribly high. At that point I decided that we could somehow squeeze the chamber out of our dwindling construction costs. And so we, and by we I mean Ned Goldwasser and other physicists working on the experimental facilities, asked the bubble chamber advocates to come up with a more modest, but yet still adequate, design. Just then a "Fairy Godmother" in the form of Bill Wallenmeyer of the AEC appeared, waved a magic wand, and pried out new funds, from whence I never did understand. That Brookhaven National Laboratory made the design, that the Argonne National Laboratory would build the huge superconducting magnet, and that the Stanford Linear Accelerator Center would build the piston were also vital ingredients in moving forward with the project.

The new funds were, as I remember, about \$7 million. In the contriving that went into determining just how much they should be, I had made an obligation that it be a 15-ft bubble chamber. Somehow, in the rush to a new design, which meant essentially just doubling the 7-ft BNL design, the diameter was reduced to 14 feet. I insisted, for no other reason than my own credibility, that we stick to 15. So as not to have to make a whole new design, it occurred to me that a small, one-foot-long conical extension on the front of the chamber would keep me honest, and might even find some use in extending the length of the damn thing. I learned somewhat later that there were some comedians who referred to it, with egregious *lese majeste*, as the "Wilson Nose."

Soon after, Bill Fowler joined the Laboratory to see the project through - a great day for Fermilab. Not much later, Russ Huson joined him. I always felt that the sophistication of the engineering on the 15-ft Bubble Chamber far exceeded what we were doing on the Accelerator. It was a delight for me, every now and then, to pause in our mad race and admire the bravura performance of our clever new friends.

One of the fantasies that I had acquired during the lengthy discussions about the chamber was that it would sit out on the lone prairie in its shiny spherical magnificence about a mile from the Central Laboratory Building. In this case, architecture would not only reflect the function, it would be the function, or vice-versa. It finally became evident to me that the topography was such that the top of the chamber might just about stick up above ground, if that, and that the miserable Neutrino berm would conceal everything anyway. I was so angry that I didn't know whether to cancel the Neutrino experiments or the 15-ft Bubble Chamber itself!

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The resolute Fowler and Huson were not to be deterred by my architectural whimsey. They came to me with wily smiles - they would fight fire with fire. The 15-ft Bubble Chamber would need an assembly building, they informed me. Aha, more money yet, I thought to myself. The new building, which would also be the operational center, would sit next to the bubble chamber, and it would have a huge bubble, indeed, a Fuller dome, sitting on top of it as a necessary part of it. That got to me. Soon my anger dissipated as we busily started the design. In fact, Russ already had a design in his pocket, and I even forgave him for that in the general euphoria of the moment.

When we turned our thoughts over to the professional architects of DUSAF, our architect/engineer consortium, they informed us that Fuller buildings had become expensive - way beyond what I was willing to spend. Still, the idea of a domed structure was irresistible, so we cut a deal with DUSAF that they would design and build the bottom floor of the building and we would take responsibility for the dome. Everybody seemed to get into the act, but Bob Sheldon, an innovative chemist working in the [magnet] coil factory at West Chicago, came up with a brilliant idea for a new kind of sandwich board that promised to be strong, cheap, and beautiful. It was to consist of two plastic layers between which beer cans would be stacked side by side in a hexagonal array and then cemented into place. Instead of a dome, I chose an icosahedron shape, which I thought would look like a jewel sitting on top of the rectangular-based building, but with its five sides it was something of a problem. Hank Hinterberger, our chief engineer, designed a steel structure to support the facets of the icosahedronic dome. The plates were triangles nine feet on each side and were made in our coil factory. The thin plastic layers were translucent and of different colors. The beer cans were collected from the parking area of the factory by a local Boy Scout Troop - our first community project. The tops and bottoms of the cans were removed so that when assembled, the translucent plastic took on the appearance of stained glass. The building was thoroughly satisfactory, even though the plastic decomposed in the sunlight over the years and has now been replaced by copper panels.

Well, I am getting deeper and deeper into superficialities which have little to do with the substance of the 15-ft Bubble Chamber, which is being addressed in the other contributions to this volume. Quite apart from the bubble chamber itself, building it brought a technical sophistication to Fermilab that was to permeate the whole Lab, and was eventually even to make the superconducting TEVATRON a realizable possibility. Memories, pleasant memories.

**II.****Jim Ellermeier**

*(Formerly with the Operations Group, 15-ft. Bubble Chamber; now with the Research Division Cryogenics Department)*

When Thornton [Murphy, "15 Foot Fest" Chairman] asked me if I'd say a few words today, I asked him what he had in mind, and basically he thought it would be a good idea to have someone who has been through the trenches say a few words. So I guess this talk is given by someone who's been in the trenches to those who were in the trenches with him.

First of all, there seems to be a misconception about the exact location of the 15-ft Bubble Chamber. If you got instructions to go to the bubble chamber, the person giving the instructions would probably say something like, "Well, just go to the end of the Neutrino beamline, Road A. There is this strange-looking building down there and it's got this really weird-looking roof on it. That's the 15-ft Bubble Chamber." So, people would walk into the building and ask "Where's the bubble chamber?" We'd say, "Well, you're pretty close to it, but actually you're about 200 feet away." A lot of people were very confused by that. Other people might ask, "Well, what do you do at the bubble chamber?" and still others would answer, "Well, they've got this huge sphere of 10,000 gallons of hydrogen that has this piston in it. They pulse it up and down and they shoot particle beams through it and take pictures." In point of fact, that is pretty close to exactly what went on out there. It's really kind of hard to describe all that went on at the Bubble Chamber. People would ask, "What do you do there?", and we'd describe what it was that we did and the longer we talked the more confused they got. Eventually I just simplified my answer to, "I work at Fermilab" and that would suffice.

Basically you had to be a jack-of-all-trades to work at Fermilab. You had to know a little bit about electronics, hydraulics, mechanics, cryogenics, and vacuum systems, and if you could master a few of those, you could do pretty well as a bubble chamber technician. During the interview for a job at the 15-ft Bubble Chamber they'd ask you a lot of questions, but you had no idea what they were talking about. You couldn't even fake an answer for a lot of things. When interviewing, they always asked two questions. The first one was, "Are you willing to get your hands dirty?" After you'd been hired you knew what that really meant was, "Are you willing to overhaul compressors?" The second question they always asked potential employees was, "Are you willing to work rotating shift work?" After a while, you knew that this question should be interpreted as, "Are you willing to work midnights on only two hours sleep?"

Shifts always rotated when we were taking physics data and that was an extremely tough time for a lot of people. Most people thought midnights were defi-

nately the worst shift. I remember my first set of midnights. I had only been at Fermilab about two weeks and they said, "Well, we're ready to start shift work." I said "Well, here it comes." My shift was the one that was going to start at midnight, so I came in at a few minutes before 12 after only two hours sleep and John Stoffel, the Operations Chief, said to the crew, "Well, our assignment for tonight is to stack zinc in the vacuum space." (Bob Ferry was the Crew Chief and Jack Rossetto and Del Wilslef were there.) I said to them, "Well, I don't know what that means, but let's hit it." So, we walk down to Lab B and the building was literally full of pallets stacked with slabs of zinc which were about 18 inches long, an inch and a half thick, and 4 inches wide. We spent the next set of midnights putting that zinc into the vacuum space. Seven midnights and 60,000 pounds of zinc later, we completed the job. I'll remember that for the rest of my life. I said to myself, "If this is high-tech, then Fermilab is not the place for me."

When most people think about the 15-ft Bubble Chamber, they probably remember particular events and situations they were involved in and the people that they worked with. One of the big things that comes to my mind was the time that the chamber piston seized. The cap fell off of the emulsion box and became lodged at the side of the piston. We were taking pictures and all of a sudden we couldn't expand the chamber. It took some time before we figured out what was going on. We had to completely disassemble the device before we really knew what the problem was. That was a big job and a lot of work for a lot of people. As previously mentioned, we tested the integrity of our magnet only once. I happened to be there when it happened. There was a young technician on top of the chamber at the moment it happened and he must have thought that the end of the world was coming. When that rupture disk went, the noise was simply incredible and the vapor cloud went all the way to Casey's Pond. The lab behind us called the [Fermilab] Fire Department because they just knew we'd blown the place up.

A lot of us remember the old hydrogen compressor, better known as the "Red Lemon." What you had to do was overhaul that thing at least twice a week, typically on Sunday afternoon, so everyone hated Sundays. If you got to be lucky enough to double back, that was your gift for doubling back on our shift. Doubling back meant that you worked till midnight, then came in at 7:30 the next morning and got to overhaul the Red Lemon compressor. Then there were the stainless steel plates. A lot of us spent a lot of time polishing and grinding them so that they wouldn't boil in the chamber. The expansion system; a lot of us spent a lot of time down in the pit fixing oil leaks. There was nothing worse than working in Lab B and seeing a mist of oil coming from the expansion system because you knew exactly what was going on. There were so many improvements made on that system in the last few years that many of the newer technicians didn't know what it was like to work on that expansion system constantly.

Working at Lab B was always a "joy," too. It was hot in the summer and cold in the winter. We all can remember stacking up the expansion system in the pit and going through lots of long hours, particularly on midnights, putting that expansion system together. The original crew at the bubble chamber that started the cooldown in June and July of 1973 was made up of experienced people, mainly from Brookhaven and Argonne. Some of these people are still here at the Laboratory. The leaders at that time were George Mulholland and Hans Kautzky, and the emergency forces were Carl Pallaver and Paul Thorkelson. The crews consisted of John Stoffel, Asa Newman, George Athanasiou, John Foglesong, Bob Stover, Stan Tonkin, Denny Curtis, Bill Noe, Sr., Dick Almon, Jim Kilmer, and George Simon who just retired from the laboratory about a year ago. Then there were Frank Bellinger, Johnny Colvan, Colby Pitts, Gene Beck, Ron Davis, John Woodworth, Mike Morgan, Bob Ferry, Jim White, Jerry Kadow, Steve Johnson and Chuck McNeal.

These particular crews accomplished many "firsts" because they were the first crews to cool the apparatus down. The cooldown of the chamber started on June 23, 1973, and they had the first liquid in it nine days later on July 2, 1973. The chamber was full and controlling seven days later with no problems at all. This was quite an accomplishment given that it was all being done for the very first time. There weren't too many hitches. When we first started keeping our log books, everything went into a green log. I'm sure that anyone who's been around the chamber has certainly seen some of them. It's ironic, but we went through exactly 100 of these green log books in the 15 years that the bubble chamber operated. We finished our last run using log book number 100.

In our 15 years of operation, we had only one woman technician who worked at the bubble chamber. She was only with us for about a year and a half. In addition, we certainly depended a lot on our other female support staff, our secretaries Elsie Renaud, Denise Augustine, Norma Johnson, and Bert Forester. Bert started about two weeks before I did and worked at the bubble chamber for over ten years. She left about three years ago and was replaced by Claudia Foster who stayed about a year.

Then, of course, there were all of our welders and machinists: Larry Bingham (our first welder), Mark Krueger, Ivan Stauersboll, along with Sam Alexander, John Ramus, and Don Fisher, who replaced Sam when he retired about ten years ago. Then we had a member of the crew out there who was always on midnights, even when we weren't working shift work, and he was Dave Lyden. He'd call you at home because something was wrong and he'd do just about anything to fix the problem, anything except dump the fluid out of the chamber. We appreciated him a lot.

We didn't work all the time. We also had some fun. One of the things that was very enjoyable was the bubble chamber softball team. We were just a rag-tag bunch of guys who got together every once in a while to play ball and always had an annual game against the Accelerator Division. I don't know how that series came out, but I'm sure the bubble chamber ended up winning more games than Accelerator did. Bob Pucci was always our pitcher and we'd leave him in until he'd start walking runs home, then we would punish him by yanking him out of the game onto the bench and putting someone else in. They probably did worse than he would have, but we thought we had to do something about Pucci. George Mulholland, Wes Smart, and Jim Kilmer always cringed when they knew it was time to play a ball game because you could guarantee that the next day at least half of the crew had something wrong with them. George, Wes, and Jim would go around and make a health check on everybody and, at best, you were probably stiff and sore for two or three days after. Although there were a lot of muscle pulls and a number of broken fingers, we sustained a lot more injuries from what we called the "post-game festivities." If we had refreshments at the game, it would continue there after the game until it got dark, then we'd adjourn to the Users Center. We always felt this driving obligation to make sure that the Users Center closed on time and most of us saw that that happened.

We had six people who retired from the bubble chamber in 15 years. They were Stan Tonkin, Sam Alexander, Asa Newman, Harry Stapay, Paul Thorkelson (who is in Florida), and George Simon. Paul Thorkelson, for those that are interested, sent a letter and it's in the sign-up book. He regretted not being able to come.

I would like to make a comment about safety. I think that the technicians really deserve a lot of credit for keeping that place as safe as it was for 15 years. I remember one of the meetings we had right before this last run. Thornton was talking to us and he said, "I think this last run ought to really go off with a big bang." Then he said, "Wait a minute, wait a minute, no, no. That's not what I meant. I think you get the idea, but let's not do that."

In closing, I would like to give some credit to the wives and families of all the guys who worked at the bubble chamber over the years. We know that working on a rotating shift is very hard on the technicians, but it is very hard on the wives and families, too. There were a lot of things that we had to give up and miss; a lot of anniversaries, a lot of school functions, a lot of sporting functions that we just weren't able to attend. It's a big sacrifice for the family, too, so I think in appreciation of their sacrifice, I would like to say thank you to them. I think they deserve a round of applause.