Chapter 2

SEARCH FOR A ROLE, 1919–1930

The research and service work undertaken by the Bartlesville Experiment Station through the 1920s responded to the needs of oil producers in the "Mid-Continent region" comprising Oklahoma, Kansas, the Texas panhandle, and north-central Texas. Several factors gave elements of the Bartlesville station's early research agenda national and even international significance.

Defining a Role—Ideology and Technology

Discoveries in the Osage Indian Nation (by then Osage County, Oklahoma), directly to the west of Bartlesville, between 1917 and 1922 alleviated fears of a severe oil shortage in the United States and catapulted Oklahoma to the forefront as an oil boom region and as a potential solution to the national fuel crisis. Other fields in Oklahoma developed through the early 1920s, including the Hewitt, Comanche, Deaner, Slick, and Chickasha fields, continued to increase known reserves and further ease the shortage. By 1925–1926, two-thirds of American oil production (including earlier Oklahoma discoveries such as the Glenn, Cushing, and Healdton fields) was in the mid-continent region served by Bartlesville.[1]

Even so, the demand for gasoline to run the burgeoning numbers of automobiles in the 1920s threatened to outstrip the booming oil production of Oklahoma and the surrounding region. Although statistics were difficult to gather, and the mechanics of oil field "production decline curves" were understood only in an approximate sense—making secure projections of supply against demand extremely difficult—the potential problem of insufficient supply was clear. Staff at the Bartlesville station worked on a wide variety of local projects for improving production techniques which, because of the importance of the local environment to the overall oil picture, had national significance. As they journeyed into the newly opening fields, such as the major Seminole field in 1925, to assist individual drillers in solving problems including underground water invading wells, they rightly saw these particular local services as having potentially wide importance.

Service to the oil producers in the region had considerable national importance; however, a number of ideological and practical factors limited and constrained the station's choice of projects and activities. First, at the national level, Bureau of Mines personnel expressed a conservationist philosophy that dominated the outlook of specialists throughout the Department of the Interior. "Conservation," as applied by Bureau personnel to the oil industry, conveyed a meaning similar to its application to forestry, water resources, soil, and minerals. As noted in Chapter 1, the Bureau of Mines specialists concerned with oil and natural gas believed that they should develop information and techniques which would lead to more efficient recovery and better utilization of resources. Those specialists thought they should study ways to find reserves, effectively utilize gas pressure to bring crude oil to the surface, make use of the gas that the oil industry treated as a waste product to be vented, and prevent loss through evaporation or leakage. Their argument was that such studies could aid the individual producer while at the same time serve the national interest by protecting the natural resources of petroleum or natural gas. Businessmen would become scientifically informed, would use the most enlightened methods, and thus would serve both the private and the public interest.

Henry Doherty, who headed Empire Fuel and Gas, the predecessor of Cities Service Corporation, at that time maintained company headquarters in the town of Bartlesville. Doherty, who had pledged half of the Chamber of Commerce's original $50,000 for the experiment station, was regarded throughout the oil industry as an advocate of such enlightened, scientific business practices. In particular, Doherty hired technicians and scientists, including some who worked briefly for the Bureau in Bartlesville, and he advocated conservation of resources as a means of protecting both price and the nation's resources.

Similar principles from the "gospel of efficiency" lay behind the work of agricultural experts in soil conservation and behind the approach of government experts in general to the technical problems of resource development through the 1920s. If an individual oil producer could be convinced to undertake a technique because of its potential profit, which would at the same time enhance conservation, so much the better. Of course, it would be nearly impossible, without restrictive or regulatory legislation at the state or national level, to encourage conservation measures that were counter-profitable. Although Bureau personnel did feel free to advise that such rules be passed, the Bureau did not regard itself as an enforcement agency, and was careful to maintain a cooperative rather than controlling relationship with industry. To the extent possible, Bureau of Mines personnel sought voluntary cooperation in conservation techniques (which tended to be profitable for the producer), with the ultimate objective of serving the national interest in the efficient use of natural resources.[2]

As the Bureau of Mines technicians at Bartlesville developed techniques and studies with the emphasis on profitability, they won a warm reception and an excellent reputation with some of the producing companies of Oklahoma, particularly the Phillips Petroleum Company and Doherty's Empire Fuel and Gas Company, both based in Bartlesville, the Pure Oil Company, based in Tulsa, as well as with a number of smaller firms.

Relationships with industry were helped further in 1925, when the Bureau of Mines was transferred to the Department of Commerce (then under Herbert Hoover), following the exposure of Secretary of the Interior Albert Fall for taking bribes for the release of Teapot Dome Naval oil reserves in Wyoming for private production. The Bureau of Mines was able to use this transfer to shift the few regulatory tasks performed by the Bureau—such as supervision of drilling and production on public land—to the U.S. Geological Survey. This decision left the Bureau, in its new role as a Department of Commerce agency, free to cooperate with and serve private industry with no taint of regulation. R. A. Cattell, who was responsible for this decision, later regarded it as one of the smartest moves he ever made. It permitted the Bureau of Mines engineers to have access to proprietary information and to private oil sites that never would have been shown to a representative of a regulatory body.

Secretary Hoover, himself an engineer seeking to apply engineering procedures to a variety of government problems, advocated organized cooperation between government and business. Hoover believed that government experts, working with private experts in industry-wide associations, could secure voluntary cooperation and adherence to standards. Hoover hoped that the government could play a mediatory role in the public interest and insure that working technical solutions and standards with industry-wide application would be established. His favored method of structuring such cooperation was through joint industry-government committees throughout his Department. But a high degree of cooperation, through a less structured form than Hoover sought, already existed at the Bureau of Mines experiment stations.

It was the practice of the day for associations of businesses on opposite sides of particular markets to engage in negotiations, sometimes amicable, often contentious, to determine price arrangements, quality, and standards. Where government experts could be called in, they sometimes took the role of witnesses or observers, with the hope that their presence would add a quality of legitimation or objectivity to a procedure advocated by one side over another. But they were not in a position to advocate effectively any particular method or to secure the adoption of any procedure they regarded as objectively more accurate or fair. Business associations, by their nature, sometimes negotiated settlements of national importance, often representing countervailing sectors of the economy. In such negotiations, neither side was concerned to advocate the "public" interest.

Hoover's ideal was of an impartial government role that would meet the need for an objective voice to represent the national or public interest. Some technical men throughout government hoped that they could play just such a role of advocate of the national interest, and the issue of exactly how to insert the government into association negotiations was a major ideological and political issue from the years of the Harding administration (1921–1922) through the First New Deal of Franklin Roosevelt (1933–1934). Although engineers at the Bureau of Mines had the knowledge and political awareness to become involved in the early 1920s, the record shows that their participation was limited, tangential, and sometimes forced upon them for reasons they regarded as unscientific.

Through the 1920s, two philosophies or ideologies, not always compatible, lay behind the work undertaken at the Bartlesville station. On the one hand, the Progressive-era conservationist philosophy predominant at the Department of the Interior dictated a leadership role for the station in finding and advocating efficient practices which would conserve natural resources in the national interest. On the other hand, efforts to play a mediating or consulting role to industry associations, in accord with the Hoover philosophy of mediation and interindustry brokerage predominant at the Commerce Department, often led Bureau men into the politics of pricing and standardization. In other words, the transfer of the Bureau of Mines from Interior to Com-

merce resulted, not in a clean break in "ideology," but rather in a blend of the two approaches. At Bartlesville, the blend was reflected in a kind of inertia, as the older personnel, committed to the conservation doctrine and to the "gospel of efficiency" in the national interest, stayed on at the station in the new situation and with the new pressures. When opportunities to cooperate with industry came along, or instructions came from Washington which would engage the station's technical personnel in the politics of pricing or the politics of standard-making, they sought to find a path which would avoid "taking sides" or making enemies in any sector of the petroleum industry. One way to do this was for station representatives to structure their cooperation with industry on a local, practical basis. Whenever contention or controversy between different sides of the market in industry or between industry and government threatened to disrupt such cooperation, Bureau men in this period voiced a preference for staying clear of the debates in the interest of preserving good relations—relations that had derived from the successful efforts of the station to develop profitable means of conserving oil and gas and the resulting willingness of oil producers to work with them.

This desire on the part of station staff to secure and continue a cooperative working relationship with local producers was conscious and explicit, and had begun several years before the requests issued by Hoover as Commerce Secretary for more formal implementation of procedures for cooperation. As we examine the specific technical projects undertaken from the station through the period, we shall see that the station's technical people worked strenuously to keep such cooperation within the ethical standards of the era.

The ethical issue of exactly what form government service to industry should take concerned Bureau of Mines personnel from the beginning. On the one hand, the use of funds derived from general taxation to assist an individual oil man in making a profit would be unconscionable unless it could be adequately shown that the results of work would benefit the industry more widely, and that the resulting techniques and information could result in more efficient utilization of natural resources—that is to say, in conservation. On the other hand, publication or even public discussion of proprietary information derived from close cooperation with a private firm could easily damage that firm's profit expectations and would represent an abuse of the power of the state over the individual. Oil men guarded jealously details of drilling depth, production figures, and decline rates of individual wells. Such information might enable competing drillers on nearby leases to drain a field. Under the "law of capture," whoever first recovered oil owned it just as, under game laws, whoever owned the land into which game wandered was entitled to the profit of its capture. If Bureau personnel published details that allowed a competing driller to secure oil from a driller who had cooperated with the government, such cooperation would clearly be endangered in the future, as the individual's right to a fair profit on his investment would clearly have been abused. The Bureau charted its path carefully to avoid either pitfall.

As men at the station worked with producers in an attempt to encourage such pooling of information, they entered a new area of activity. If information could be pooled under the guidance of technically trained but financially disinterested government experts, cooperation between enlightened businessmen under government leadership could accomplish greater production. The most notable achievements of the station in its first years were in precisely such activities.

Other dilemmas constrained the activities of the researchers at Bartlesville. Under the General Order establishing the experiment stations, each laboratory was instructed to cooperate with local producers, educational institutions, and experts in its field. Further, the station was to cooperate with other federal agencies in the region that were assigned responsibility for related matters. In the case of Bartlesville, before the 1925 shift to the Department of Commerce, this provision meant that the station acted in an advisory capacity to the Indian Agents throughout Oklahoma who were responsible for tribal lands leased to private companies for oil production. Located less than twenty miles from Pawhuska, county seat of Osage county and national capital of the Osage Nation, the Bartlesville station coped with a series of issues for the tribe. Techniques that aided conservation through efficient production would assist both the tribe and the oil producers working on tribal land; but disputes over measurement of production, the value of production, and the method of calculating royalties to be paid to the tribe could clearly place Bureau of Mines personnel in the difficult position of advocating the interests of one side against the other. Where did the national interest lie? How could the station suggest reforms that would aid the Indian side without endangering cooperation and good relations with the producers? How could the Bureau of Mines, one branch of the Department of the Interior until 1925, side against the Bureau of Indian Affairs, also in Interior, without creating a violent intradepartmental dispute? Again, such practical political problems reflected deep-seated ethical issues. The national government had to serve simultaneously as guardian of tribal holdings and as advocate of efficient use of national resources. When such objectives appeared to conflict on a specific case, what was the proper role of a government laboratory?[3]

Practical Problems in Getting Started

Such limitations shaped the broad outlines of research and service at the Bartlesville station through the 1920s. Even more mundane day-to-day considerations affected the start-up and termination of specific projects. As the station opened, it suffered not only from the constraints of policy and practical difficulties derived from slow acquisition of equipment and the loss of personnel, but also from limited funds. The construction of the laboratory and the accumulation of equipment proceeded slowly, limiting the activities of the station in its first three years to the application of published information, or safety and engineering principles which were well-known to trained engineers. Station advisors faced vast travel requirements to drilling sites often located up nearly inaccessible dirt tracks that made the field work akin to desert exploration. Despite such handicaps, however, the station engaged in a number of research projects in its formative years and produced a highly creditable record.

Even before the station opened, however, Bureau of Mines staff had begun field work in Oklahoma. In 1915, for example, water began flowing into wells in the Cushing field and prevented recovery of gas. The *Oil and Gas Journal* noted that W. F. McMurray of the Bureau of Mines visited Vera, Oklahoma, and recommended that mud (cement) plugs be used to prevent flooding; his advice benefited both the producers and the local farmers, who complained that the briny water was damaging their crops. By 1916, the reports of cement plugging procedures, published as a Bureau of Mines bulletin, were in wide demand; and an earlier brief report, published as a pair of Technical Papers, sold out.[4]

J. O. Lewis, appointed as first Superintendent of the station, headed a staff of six who, in the first months of operation early in 1918, worked out of temporary offices provided by the Bartlesville Chamber of Commerce. During this period, Lewis concerned himself with ordering equipment, lining up a contractor for construction of buildings on the lands provided, going over floor plans, and discussing plans for research and technical work with local oil men. The first contractor was unable to post bond, and Lewis arranged for another. In the rush of such business, he filed brief ten- or fifteen-line reports giving only an outline of his efforts. Dorsey A. Lyons, head of the Bureau of Mines office supervising the experiment stations, insisted on fuller reports spelling out the exact nature of discussions, the parties involved, and other details. By April 1918, Lewis's monthly reports were conforming to the request. Thus, even before the station formally opened, the station began the tradition of comprehensive monthly reports by the Superintendent to the Bureau in Washington, D.C. Year after year, such reports, although self-consciously written to put the best light on the station's work, would provide a steady and continuous core of documentation of the station's operation.

In the April report, Lewis noted that he was studying responses to a questionnaire sent to the local oil company officials regarding the sort of work they thought the station should undertake, and he commented on the high degree of support and interest the station received. In particular, Empire Fuel and Gas and the Gypsy Oil Company sought Lewis's cooperation in a "campaign looking to the shutting off of water from oil wells and prevention of damage to oil wells by water infiltration, similar to the campaign conducted by the Bureau on the conservation of gas."

Lewis soon supplemented his staff with the addition of an expert oil driller, Thomas Curtin, who transferred from the Indian Service to the Bureau of Mines. Beginning in May 1918, Curtin began to consult with drillers in Butler County, Kansas, on methods of cementing wells to cut off intruding water. R. O. Neal, on the staff of the station as an Assistant Chemical Engineer, wrote and published two papers on methods of tracing the sources of intruding waters, and Lewis noted that the purpose of the papers was "to attract the attention of operators to [the need for] shutting off water."[5]

Thomas Curtin continued to work as a field agent through 1918, giving advice on methods of shutting off water in crude oil wells. Curtin's adventures and problems illustrated a variety of issues which would continue to plague the facility over the coming years. At first, Curtin found his position somewhat ambiguous on a couple of counts. By weekly letter, he reported directly to Washington, sending a copy to Lewis at the Bartlesville station. By November, he suggested that he report through Bartlesville alone. Lewis agreed, telling Curtin that he need keep Charles Naramore, his supervisor in Washington, posted only on important developments.

A more serious difficulty was that Curtin's work often took the form of direct personal assistance to oil drillers in correcting their problems and resulted in lengthy stays in isolated spots—on government salary—assisting the private drilling companies in work that had little or no long-range regional or national purpose. In a trial-and-error fashion, Lewis sought a path between government service in the interest of Mid-Continent producers in general and private assistance to a single profit-making enterprise. Curtin commented from Sulphur, Oklahoma, that "[I] am decidedly impatient about this whole affair and it would be very easy to put a wrong construction upon my stay here, but I see no way other than rank desertion, of pushing the work faster than I am at present." Physical conditions contributed to Curtin's displeasure—he scrawled at the bottom of one of his typed reports: "I

have not shaved for seven days. Almost impossible to do so." More seriously, he was troubled by the insistence of oil well operators that he stay on to solve their problems.[10]

Early in 1919, matters got worse for Curtin. One of the companies with which he worked in Murray County insisted that he give some further help. The company wanted him permanently assigned, for they found that his solutions to waterflooding problems were only temporary and, whenever he left, their production soon ground to a halt. Curtin also found that, in discussing the matter over party-line telephones, he needed a "code," because the information was leaked and land prices began to climb. Lewis did not think it was Curtin's role to save private firms the expense of hiring someone to do the same work, telling him that "our work is dealing with conditions that are new or methods that are not familiar to the ordinary producers in the Mid-Continent." In line with this view, Lewis finally wrote to the firm, withdrawing Curtin's services. He told them that Curtin felt any competent driller could handle their well, and that he was cutting off any further funds for Curtin's work with them.[11]

A more successful early project was that of W. P. Dykema, Assistant Petroleum Engineer, who undertook a study of the method of recovering gasoline from natural gas by absorption. Natural gas occurring in crude oil wells contains gasoline in vapor form, which usually has large proportions of compounds with octane numbers high enough to approximate what is now called 100-octane gasoline. Such gasoline, commonly called casinghead gasoline (since the vapors are now collected at the well casing head), was far too explosive when used directly in the engines of the early twentieth century. Typical practice, therefore, was simply to vent it to the atmosphere, particularly in areas not served by collecting gas pipelines. When used as a blending agent, however, it could serve to enrich and raise the quality of the lower octane gasolines produced either from cracking crude oil or from straight-run fractional distillation. Thus, an extremely valuable product was simply wasted in a great many wells devoted to producing crude oil. Dykema was allowed under a cooperative agreement to study two plants, both at Bartlesville, as they were being constructed: one using a compression (or refrigeration) method set up by the National Oil and Development Company; the other using an absorption method set up by Phillips Petroleum. Dykema's work and resulting Bureau of Mines bulletins on the methods of recovering this product met the ideal of the Bureau in publicizing a technique that would lead to conservation as defined by the Bureau. Signal Oil Company of California, founded in 1919 by Sam Mosher, was established on the basis of the application of Dykema's absorption method as reported in the bulletin. Casinghead gasoline previously wasted at the flush new field located on Signal Hill in Los Angeles became the product of the new company and the basis of a rapidly growing fortune for Mosher.[6]

This and other early cooperative projects demonstrated how the two-way relationship with industry would work. Although the profits to be derived from casinghead gasoline were potentially vast if the natural gas vapors were rich in gasoline, construction for both absorption and compression methods was quite simple. And the technology, if carried from Oklahoma to other areas, would benefit the nation as a whole. In explaining the results of his investigation into casinghead gasoline plants, Dykema noted that experiments with the compression method for obtaining the gasoline seemed wasteful and, for the same reason, recommended a charcoal absorption method over an oil absorption method.[7]

In the mid-summer of 1918, the first two permanent station buildings were constructed on the two-block site in a residential section three blocks from Bartlesville's main street on the west side of town. Surrounded by small bungalows housing workers at the nearby Phillips Petroleum company, the small red brick buildings resembled the grammar schools found throughout smaller communities in mid-America.

Even as the buildings were under construction, the Mid-Continent Oil and Gas Association took an active interest in the research agenda items for the emerging station. Director of the Bureau of Mines, Van Manning (who later served as research director for the American Petroleum Institute), noted in a written outline of the projected research concerns of the station that the new station was to be "a laboratory for practical research for solving problems, devising new methods, preventing wastes, effecting economies and for collecting and disseminating information." Excerpts from Van Manning's outline were sent to the members of the Association by the organization's vice president, J. F. Darby, with the note that all the topics were of "particular importance in the Mid-Continent." Van Manning's list included:

- capacities and characteristics of oil and gas sands;
- inquiry into properties of oil not extracted under present methods;
- effects of shooting (using explosive charges to fracture the oil-bearing formation around the wellbore);
- methods for stimulating production and increasing the extraction of oil; and
- use of waterflooding for increasing the extraction of oil.[8]

Van Manning also included a number of topics related to pumping of wells which, Darby noted approvingly, were of particular interest in Oklahoma. The excerpts sent to the Mid-Continent producers did

not mention Van Manning's interest in the national implications of the work, however, or the Bureau's dedication to conservation. A section of his statement which the Mid-Continent Association did not quote states that investigations would not be limited to any one branch of the industry nor to any one part of the country. Rather, research would go on wherever opportunities appeared for increasing efficiency, whether in the drilling of wells, in the producing or transporting of oil and gas, or in the storing, refining, or utilization of oil and its products.

Ignoring these national elements of Van Manning's statement, the Mid-Continent producers instead chose to emphasize only the local and regional significance of the station. This tension between the regional and the national emphasis persisted, to be resolved neither formally nor informally in either the station's planning or the oil industry's perception of the station's role.[9]

Avoidance of Technological Controversy

In 1918, the Bartlesville station and, through it, the Bureau of Mines were drawn into a controversy surrounding the pricing of casinghead gasoline derived from oil wells on the Osage lands. Under a proposed regulation change issued by the Bureau of Indian Affairs, royalties were to be paid on casinghead gasoline to the leaseholder on the basis of the price paid for regular gasoline in Chicago. In the opinion of Dykema, the Bureau's expert on casinghead gasoline, such pricing was the worst possible deal for the Indian. Among other reasons, the price of casinghead gasoline should be higher than regular gasoline, because it was used as a blending agent to raise the quality and the price of the gasoline to which it was added.[12] Dykema's opinion in this case ran counter to the oil producer's position, but the station, under Lewis's supervision, was careful to avoid taking a local role as mediator or policymaker, for fear of any controversy that might endanger relations with local oil men.

In December 1918, Lewis suggested a guideline on controversial issues. Lewis believed it would be desirable for the experiment station to restrict its activities absolutely to experimental work and to keep out of anything "that savors of a political or regulatory nature." Lewis did not think that the "two lines of work [research and mediation]" were going to mix well. He hoped to keep the station "absolutely free" from taking a position and to make it clear to oil men that the station refused to do so. In this way, Lewis believed he could get their "fullest cooperation in experimental work."[13] Dorsey A. Lyons, Supervisor of all the Bureau's experiment stations, agreed that "it is desirable for the Bartlesville station . . . to restrict its activities absolutely to experimental work and to keep out of anything that savors of a political or regulatory nature."[14]

Despite the agreement to stay clear of the issue, the station finally did submit its opinion on Osage pricing through an internal memorandum. By June 1919, Lewis had moved to Washington as Chief Petroleum Technologist, and he sought to obtain Dykema's opinion on the casinghead gasoline pricing regulation for relay to the Director of Indian Affairs. Dykema, now Superintendent of the Bartlesville station, sent his frank objections about the regulation to both local and national Indian Affairs officers.[15]

Dykema's eventual report was an exception, however, to the general principle developed by Lewis and Lyons, which did place useful limits on the Bureau's involvement in controversies. In order to avoid endangering relations with technical men in the oil industry, opinions, especially if they ran counter to oil industry positions, were henceforth submitted through Washington. For the next two decades, the station would avoid taking a position, especially at the local level, which could savor of regulatory behavior or of politics.

Oil Production Problems– An Emerging Specialization

In January 1920, Dykema left the station to take a position in private industry; A. W. Ambrose, who headed a Production Problem Department at the station which had been set up in May of the previous year, was appointed station Superintendent. During his tenure as Superintendent, Ambrose emphasized continuing field work and saw to the preparation of a series of oil field studies. He personally authored a Bureau of Mines bulletin, *Underground Conditions in Oil Fields* (#195) that, due to lack of government funding, was printed in serialized form in the *National Petroleum News* early in 1920.[16]

Shortly after he became Superintendent, Ambrose prepared a brief history of the station from its founding. He discussed with obvious pride the oil field development problems pursued by the station, outlining, in particular, the studies made in 1920 of the Walters oil and gas field and the Hewitt field. In both of these studies, petroleum engineers from the station gathered all possible information—including well logs from cooperating drillers, and with "elevation" or well depth information—to develop cross sections through the oil field.[17]

Ambrose justified these activities, which clearly favored particular producers, by reasoning that limited personnel and funds dictated concentration on one subject and one local area. He planned to "work up" a field, turn the results of the investigation over to local operators, and then move on to a new field. By "working up" a field, Ambrose meant the preparation of structure contour maps, geologic cross sections, and

peg models which would show the three-dimensional nature of the underground formations, the layers of producing sands, and the presence of underground waters. Such information would allow drillers to know the exact depth to which they should drill and at what depths they should explosively fracture the formation, or "shoot the wells," to get access to producing gas or oil strata.[18]

T. E. Swigart of the station staff, assisted by F. X. Schwarzenbek, spent three months in the Hewitt field, gathering information on every well in it. A peg model, with a peg representing each well and labeled to show the depths of producing regions and other geologic information, was constructed at Bartlesville and then shipped to Ardmore. Swigart placed the model on display in the lobby of the Hotel Ardmore, where he and Schwarzenbek maintained offices for consulting with drillers.[19]

The cross sections of the field indicated a severe dip in the producing or "pay sands." Using this information, Swigart could tell particular well owners when to drill to a deeper level. A number of operators used station advice to make profitable discoveries. The Hewitt investigation ran from April through July 1920, when the crew headed by Swigart was ordered back to the station. At that point, the Ardmore Chamber of Commerce, using $1,000 in funds provided by several local operators, funded the return of the team to Hewitt for an additional two months.[20]

Ambrose saw the contribution of company funds as more than simply a convenient way to extend station services. The money served to demonstrate, Ambrose believed, the interest and support of producers in the use of scientific information. Ambrose's missionary tone in spreading the gospel of progressive drilling techniques is clear in his description of the Ardmore Chamber of Commerce decision "to contribute voluntarily this sum of money" as "very gratifying." Further, he noted that the commitment reflected considerable credit on Swigart and Schwarzenbek and proved that Bureau engineers were "demonstrating to the operators the value of engineering practices in oil field development work."[21]

The Ardmore oil men understood very well the profits to be made from Swigart's and Schwarzenbek's information. The unexpected dips and steep inclines in the Hewitt field made it an excellent demonstration of the utility of pooling information and of the benefit of a peg model in illustrating the drop-off of the producing horizon and potential areas for new discoveries. The chairman of the fund-raising committee made no secret of the fact that "the advice of these men may be worth $100,000 to my company."[22] And the Ardmore Chamber of Commerce, with Ambrose's blessing, used its own funds to publish the report on the Hewitt field.

The Bartlesville Chamber of Commerce published a similar report on the Walters field. In both cases, the local Chamber of Commerce was used to channel funds from the oil companies involved. This use of the Chamber as an intermediary for funds allowed a small number of cooperating firms to provide money to the government agency under the umbrella of the Chamber of Commerce, rather than revealing their individual identities to Bureau staff in Washington by signing a check to the Bureau directly.[23]

Information so clearly usable for the profit of a particular company was easy to "sell." Techniques which would benefit a whole field of drillers but required a capital outlay from only a single driller were far more difficult to promote. Ambrose soon confronted such a situation. The Empire Gas and Fuel Company asked him to examine the rapid decline of production in the Duncan field. Ambrose concluded that the problem stemmed from water seeping through certain higher, nonproducing wells into oil-bearing horizons and flooding out the producing wells. The wells that drained water into the oil sands (called water-strings) would have to be sealed. Since the cost of such work would be disproportionately borne by individual operators, but be of equal benefit to all working the oil sands, no one would voluntarily cement off the wells. Ambrose outlined the problem to the Oklahoma State Corporation Commission, which subsequently required the cementing to be done. In this case, therefore, the station acted counter to its desire to stimulate more efficient techniques entirely through encouragement of profit, by suggesting state government regulations which *forced* conservation measures—measures which were themselves not profitable to individual companies. The Oklahoma Corporation Commission moved cautiously in this period to establish rules to prevent excessive oil field waste; technical reports and recommendations such as those produced by Ambrose provided the specific guidelines. The station tried to "stay clear" publicly of regulations that would impair good cooperative relations with affected companies. But when the conservation ideal could not be linked to a profit-generating improvement, station engineers were willing to pass on suggestions quietly to the state regulatory body.[24]

By 1920, the staff of the station had grown from six to fifteen, and the diversity of projects reflected the staff's rich background in chemistry, petroleum engineering, reservoir study, oil field experience, and refinery engineering. Ambrose, using this enlarged staff, supervised studies on the loss of gasoline fractions from crude oil by evaporation and the possible further recovery of gasoline from residual gas vented after initial processing through compression plants deriving casinghead gasoline from natural gas.

Ambrose also started several projects which came to fruition later, including a study of the use of low-pressure natural gas to fuel oil field steam engines used to drive pumps. He supervised the construction of a small-scale experimental refinery with the object of developing methods to reduce refinery loss and a range of products, including lubricants, which could be obtained from Mid-Continent crude.

During this early period, the search for a clear-cut agenda took the station into a wide range of diverse areas. For example, the station sent a home economist, Miss Olga Elifritz, on a tour of local communities to explain consumer methods of conserving natural gas. Other projects included the building of a small-scale fractionating tower for refining studies; experiments on the absorption coefficients of crude oil to determine the proportions of natural gas, air, and casinghead gas absorbed by various crude oils; and the preparation of exhibits for the state fairs held at Oklahoma City and Muskogee and for the Independent Oil Men's Association meeting to be held in Denver. On a more scholarly level, Ambrose and his staff also gave papers at the Denver meeting. H. H. Hill, a specialist in refining work, gathered information regarding fractionating towers used in the cracking of crude oil mixtures into useable products.[25] But despite the apparent diversity, most of the research projects proposed and undertaken during 1920 did have a common thread—to increase production and to conserve against losses, with particular emphasis on the Oklahoma area.

In January 1921, Ambrose went to Washington to take the position of Chief Petroleum Technologist at the Bureau of Mines; Hill succeeded him at Bartlesville. Patterns had now been set which were to shape the development of the research facility over the following five decades.

In accord with the general order establishing the experiment station, the first three Superintendents developed considerable autonomy in setting the station's research agenda and in determining the station's function. Cooperating with local oil men, Lewis, Dykema, and Ambrose all sought to persuade producers of the value of an organized engineering approach to the problems of oil production, storage, and transportation. While the Bureau's Van Manning had indicated that the station would serve no particular section of the country nor sector of the oil industry, the emphasis that emerged under the tenure of the first three Superintendents during the first years was that preferred by the Mid-Continent Producers Association—that the station would serve primarily Oklahoma and, to a lesser extent, the surrounding areas of Kansas and Texas.

Cosponsorship of the experiment station by the Bartlesville Chamber of Commerce, representing local oil companies, and the State of Oklahoma reflected a financial and organizational blending of federal, private, and state interests. Other, national organizations had good reason to be interested in the work of the station as well. From time to time, the station received inquiries or worked towards cooperation with such regional organizations as the Mid-Continent Producers and the Independent Oil Men's Association, and professional organizations such as the Society of Automotive Engineers (SAE) and the American Institute of Mining and Mechanical Engineers (AIMME). But the real operative connection was with the Bartlesville firms of Empire Gas and Fuel and Phillips Petroleum, and smaller firms in the surrounding counties of northern and eastern Oklahoma.

Local Reputation for Objectivity and Cooperation

The rapid turnover of Superintendents and Acting Superintendents continued from 1920 through 1924, but did not prevent the station from expanding and flourishing. Good relations with local oil men paid off, not only in continued cooperative work, but also in increased contributions by the State of Oklahoma to the finances of the station, which allowed the staff of the station to increase to forty by 1925. This expansion in staff allowed for further diversity in projects and services and the preparation of a variety of written reports, published as Bureau of Mines technical papers, as bulletins, and as articles in oil industry trade journals.

The pattern of work continued to be dominated by two major areas—study of production on a field-by-field basis, and further work on various aspects of casinghead gasoline production. Station staff undertook a variety of smaller projects designed to utilize waste products or to reduce losses. Individual researchers worked on methods of recovering gasoline from vented still vapors, gas loss from pipelines, methods of producing carbon-black from gas that would otherwise have been simply vented, and the use of low-pressure gas to run steam engines used in oil field pumping, as planned by Ambrose. While such individual projects proceeded, the longer-range field work assisting on the development of oil fields through collection of data and reports on casinghead gasoline continued to build the station's reputation in these two areas of achievement.[26]

The effort by Lewis to avoid regulatory controversies was continued by subsequent Superintendents and succeeded to a large extent, although the multisided nature of the oil industry made absolute abstention from controversy difficult. For example, natural gasoline manufacturers and the refiners who purchased the product for blending disagreed on methods of evaluating the product. The Bureau avoided siding, at the national level, between the claims of industry associa-

tions on two sides of a market. The American Petroleum Institute (API) (representing the refiners) established a set of research committees with the declared purpose of establishing an objective method of evaluating the quality of gasoline; natural gasoline manufacturers suspected, however, that the procedures being tested by the committees were inaccurate. The API proposed to use the "bomb" method. This was simply a sealed vessel lowered into a tank of gasoline, opened and filled with gasoline, resealed, and removed. The contents were then heated to two pre-agreed temperatures, 90°F and 100°F, and the resulting pressure was measured by a standard pressure gauge mounted on the vessel. Both Hill and N. A. C. Smith, specialists in petroleum products, agreed from the beginning of the project that the API-proposed method of testing gasoline vapor pressure would be less accurate than laboratory distillation and hesitated to allow the Bureau to be drawn into the API-sponsored research.[27]

Early work by D. B. Dow at the Bartlesville station had spelled out a distillation method of determining gasoline volatility and vapor pressure. Natural gasoline manufacturers preferred the distillation method, but agreed to cooperate with the API's bomb tests—believing the refiners represented by the API would institute their own system of measurement even if natural gasoline people did not cooperate. Bureau personnel, despite their inclination to sympathize with the natural gasoline producers and their Natural Gas Association formed in 1921, however, hoped to avoid being drawn into the dispute on either side. Station staff member F. W. Lane doubted whether the natural gasoline people for their part really sought to establish the accuracy or usefulness of the bomb test. Rather, he believed they wanted a test which could be accepted as a standard regardless of its scientific validity, and for that reason was wary of the possibility that Bureau reports would be used politically. "The approval of any federal department," he said, would help them politically.[28] The laboratory procedures used by the private laboratories in testing the bomb methods were to Lane grossly inaccurate, because the same sample of gasoline would be used to run the two separate temperature tests rather than using a fresh sample for the second test. Bureau technicians found themselves being made to sign off as witnesses to such tests, taken inaccurately, of procedures they regarded as fundamentally unsound, in order to help resolve a controversy. Eventually, the API bomb method was adopted, but with no recognition of Bureau objections to its accuracy.

A case of interindustry potential bargaining that raised fewer hackles was one that developed between two sides of the domestic heating business. Both refiners and oil burner manufacturers hoped to develop standards for home heating oil—which would lead to efficient use of both fuel and heaters. The Bureau of Mines sent station engineers Kirwan and Youker to observe discussions held in Tulsa. The Western Petroleum Refiners Association, the Osage Oil and Gas Lessees Association, the Mid-Continent Oil and Gas Association, and the American Association of Oil Burner Manufacturers proposed to pool funds for a research project to be conducted by the Bureau of Mines itself. Through 1924, however, the proposal did not get beyond the discussion phase.[29]

In the period before 1925, only when dealing with government-held or government-administered lands did the Bureau men find themselves forced into a regulatory role. At Salt Creek, Wyoming, Bureau recommendations for evaluating the value of natural gasoline (in this case, setting the value of five cents per gallon below Chicago tank wagon price) were implemented. The Director of the Bureau of Mines in this period, H. Foster Bain, on advice from experts at the Laramie and Bartlesville stations, recommended the price set by the Secretary of the Interior. The price upon which government royalties would be charged represented "relief," to encourage the utilization of the casinghead gas which oil producers had been simply venting or burning off. Again, the Bureau used a profit incentive to discourage a practice it viewed as wasteful.[30]

The occasional disputes into which station personnel were drawn, often against their better judgment, did not prevent the main research effort of the station, which continued to result in publications designed to assist producers in eliminating waste, preventing loss, and improving efficiency. The major frustration of Superintendents and researchers alike appeared to originate from the difficulty of getting producers to adopt conservation techniques even when they were clearly profitable.

The most consistently usable work from the station in the early 1920s continued to be direct field advice. In 1924, Kirwan reported to the International Petroleum Exposition and Congress work on sixteen station research projects, including work on refinery technology, problems of gas pipeline leakage, evaporation losses from field storage tanks, and cementing studies. He noted, however, that public attention came to the station for spectacular field service such as bringing under control a cratered wild gas well in the Chickasha field, for closing a wild gas well in the Depew field in seven days after the owners had worked on it unsuccessfully for forty days, and for assisting in extinguishing a gas well fire in the Cromwell field. Kirwan noted that such work, while serving particular owners, had value to the industry more generally because it would serve as a "demonstration" of good technique. Kirwan was explicit in his hope "to cooperate with the petroleum industry in the interest of efficiency and true conservation of our natural resources."[31]

Through the early 1920s, men who had moved on from the station to industrial jobs made a practice of returning to visit. Visits of such individuals and of other industry personnel, only summarily reflected in the monthly reports, appeared to be one of the major means by which business came to be conducted at the station and one of the early methods of building the station's reputation. Through such contacts, cooperation with industry proceeded quietly and effectively on a strictly local level, without reference to the advocacy positions taken by the national or regional associations. As early as July 1921, the monthly visitor list had grown to include Bureau personnel from Washington, personnel from other stations, company officials interested in technical issues relating to natural gasoline or seeking drilling or mudding advice, as well as former station staff members.

Although government experts had the objectivity and the technical training to allow them to play a mediating role between conflicting business associations, their reluctance to be drawn into industry politics, which has been stressed repeatedly here, limited that role. The petroleum industry associations often fought one another for position and price advantage, using technology and science as arguing points, but not as tools for "objective" or impartial solutions. When Hoover and his followers advocated the application of engineering principles to administrative issues, they assumed that science and technology would provide solutions that were above political concerns and the dictates of self-interest. Government engineering provided the appearance of impartiality or national purpose, itself useful as an arguing point, but alleged government objectivity was used by industry, not as a source of independent brokerage or of mediation between conflicting sides, but as a political tool.

The Bureau's own ideal of service in the interest of conservation and efficient utilization of resources was itself not an "impartial" position, of course, because it could and did lead to advocacy of methods—sometimes costly in the short run—that industry figures would hesitate to adopt. However, brokerage or mediation, especially when the issue at stake was one of profit on one side, loss on the other side, could only result in the Bureau's losing the trust of the loser group and thus endangering the Bureau's ability to secure cooperation on field conservation techniques. Despite pressures to participate in such issues, the Bureau and its engineers hung back, preserving their credibility by abstention from policy.

The projects undertaken most successfully at the station, thus, continued to be ones that particular local oil producers could see as potentially profitable or that would solve a particular costly problem. The preferred practice of station personnel had not changed from that established by Lewis in the first year of the station's operation.[32]

The Creation of a National Reputation

In 1924, N. A. C. Smith came to the station from Washington to serve as Petroleum Technologist and Acting Superintendent. Smith, a meticulous writer with a concern for the Bureau's scholarly reputation, insisted on retaining an editorial role for all publications on oil and gas from the Bureau. Smith was appointed Superintendent of the station in 1925.* He settled into organizational and administrative tasks and remained as Superintendent, and later as Supervising Engineer, of the station through 1944.

Smith's personality, his concern for excellence in research and writing, and his attention to administrative detail were all good for the station. He led it into a period of physical growth and into a position as an independent and professional petroleum research center, continuing service work, yet publishing independent research work sometimes in advance of the needs and demands of the national oil industry. Such publication continued to put the work of the station before national audiences in the petroleum industry. Smith continued the tradition of response to local and regional demands, although he worked to prevent the station from becoming a strictly local service center. And, like his predecessors, he remained skeptical of any mediating role in disputes, whether between sectors of the petroleum industry or between government and industry. Smith's disdain for the mire of policy went further than that of his predecessors, however. A brilliant technical man, he had little patience with individuals who needed to be convinced of what he saw as an obviously technically correct procedure. Perhaps for this reason, Smith devoted less effort than had been done previously to "proselytizing" the petroleum industry to get them to adopt conservation techniques. His approach, as it developed over the late 1920s and on into the next decade, was much more academic. He would insist that a report or bulletin be accurate, that it be well printed, and that it be widely distributed. He expected, rightly or wrongly, that if the material were scientifically correct, it would be respected and used. This quality of impatience or skepticism about advocacy, and his preference for reputation based on quality, led the experiment station in a scientific rather than strictly service direction, and attracted a group of energetic researchers who made their careers at the station. Like Van Manning before him, Smith emphasized the national potential of the station and, whenever not otherwise constrained by economic and

*Smith was preceded as Superintendent for a brief period early in 1925 by E. P. Campbell.

practical concerns, kept the work of the station before a national audience.

At the beginning of his term, starting in fact during Campbell's brief tenure, a disagreement arose between the station and the Commerce Department over the question of a national advisory committee. The problem started when the Bureau of Mines, in response to recommendations by an interdepartmental committee reporting to Secretary of Commerce Hoover, began to establish a set of formal industry-government advisory committees. At the Bartlesville station, Campbell and Smith responded to the suggestion of a formal committee with skepticism. In a letter to Hill of the Bureau's national headquarters, Smith said the idea of an advisory committee "is a rather poor proposition," although he was careful to note that "an informal group of advisory or consulting engineers is very valuable, and they can call it a committee if they want to." He believed that the station should continue "to formulate our own program of work" and only consult with outside engineers after setting the program. "If we have a definite committee, I am afraid that we will have one or two members who will show a rather impertinent interest in some detailed phases of our work." Smith said he preferred to work with former Bureau and station men, now in industry, and he specifically mentioned Lewis, Ambrose, and Kirwan as "alumni."[33]

Hill had already told Folsom, the interdepartmental committee representative assigned to the Bureau, that the Petroleum Division of the Bureau of Mines had never had a formal advisory committee, but that the Division frequently obtained ideas and suggestions through informal conferences and was closer to the industry that it was intended to serve than almost any other branch of the government service (an assertion that Folsom accepted). Hill noted that some of the other experiment stations had formal advisory committees but that Bartlesville's "old plan of discussing the work only with people that are directly interested in it" was a good alternative that should be kept.[34]

Campbell was both more skeptical and more analytic than Smith. He thought an advisory committee would be politically, practically, and even financially useful to the station; however, he feared the ideal would not be achieved in practice because he doubted whether such committees could ever work well. "The average representative of the industry," he argued, "even of technical mind," could not grasp the need for a national perspective. Campbell believed that even former station personnel, now in industry, lost "sight to some degree of some of the factors that influence the selection of work that is carried on."

Campbell believed an advisory committee, if formally constituted, would be dominated by one or two individuals, and that it would not take the long view necessary to predict future needs of the industry. If a committee was required, he suggested that it include not only technical men, but men from the business side of the oil industry; technical men would keep the research too theoretical, he feared. Campbell argued that industry had accepted station work precisely because it was well-rounded, including practical, theoretical, and reporting work. Because the "gang of engineers" at the station had come from industry, they maintained contact very well without an "intermediary body." Like Smith, Campbell preferred to work with the consulting engineers, often former station men back in industry. Campbell summarized his belief thus: "An advisory committee is the 'bunk'."

The station prevailed. No formal committee was established, and the station continued to set its own agenda, with suggestions from "alumni," informal feedback from industry figures, and in response to Petroleum Division suggestions from Washington. Despite the efforts of Herbert Hoover to place liaison into a formal advisory committee structure, the station succeeded in keeping its informal contacts and its business-as-usual approach.[35]

Continuity and Publication

Through the late 1920s, Smith concentrated on response to personnel changes and research publication. Smith's monthly reports never referred to the degree to which the station's work received local acceptance or support, stressing instead the production of quality published work which would stand or fall on its own merits.

The difficulties of producing work despite personnel turnover in the year 1925–1926 were spelled out in detail. Researchers who left the station to take other positions left their projects and reports to be finished by succeeding researchers. In some cases, reports were finished by departing researchers immediately prior to their moving on; in at least one case, a researcher submitted a draft of his report and his resignation the same day.

Several examples from the station's 1925 experience illustrate the complexity of bringing research to completion during a period of extremely high personnel turnover. W. L. Williams was transferred to the United States Geologic Service on July 1, 1925, and his field work in the Cushing Field was simply discontinued. Cattell was promoted to Assistant Superintendent in October; E. Rawlins left a post with the Natural Gas Association to work for the station and take charge of Cattell's gas pipeline transmission work. Rawlins finished for publication four papers which reflected the work of himself, Cattell, and Wosk. D. B. Dow started a study of methods of increasing recovery of oil in March 1926, then resigned in two weeks. E. O. Bennett took over the project, then resigned within

three months, leaving the project in the hands of B. E. Lindsly.[36]

Through 1925 and 1926, the total complement of staff averaged about forty. Of the forty members of the staff in July 1925, fourteen had left by April 1926, and twelve new men came aboard. As Smith put it in July 1926, "During the past year this station has seen the arrival of three superintendents and the departure of two." The overall "turnover" rate in one year was about one-third of the station. From July 1925 through July 1927, the number of staff departing was twenty-one, or over 50 percent, not counting newcomers who both came and went within the period.

Although the record is not sufficiently detailed to develop a profile of the positions taken by all the departees, it is clear that several took positions with the oil industry, particularly those who had served as Superintendent, including Scott and Campbell, who both went to work for Pure Oil Company in Tulsa, and Bennett, who took a position with the Marland Oil Company. In the booming oil industry of the mid-1920s, the demand for trained chemists and engineers with practical experience was at its peak. Despite the difficulty engendered at the station in the form of half-finished projects, however, Smith and those who stayed behind did not appear to resent the departure of their colleagues; indeed, a touch of pride showed up in comments about the alumni who took responsible and high-paying posts in business.[37]

Ironically, the station's very success posed a threat to its continuity. As the technical men at the station proved to industry that their ideas and methods were valuable, companies established their own research departments and recruited their own research staff. This trend was intensified as the station, trying to address national rather than local issues and to avoid controversy, found it increasingly difficult to set a specialized agenda that filled a specific need. As the companies competed for scientists and engineers, the salaries offered soon exceeded the government levels of $2,400 to $3,000.

Smith's chosen method of combating the problems of continuity and competition from the private sector for staff was to concentrate on research that would merit publication in the best technical journals and to secure a national repute and continuity of effort by that avenue. Smith's concern for publication, in both quality and quantity, was in fact the dominant feature of his early administration. He gave details of the publication status of reports and technical papers, reporting on works that were "in preparation" or "in press" as well as those that were published. In 1925–1926, Smith listed three papers published and another four in press. In 1927–1928, he could claim twenty publications from the station, including eleven Reports of Investigations published as Bureau of Mines serial items, four Bureau of Mines Bulletins, and five articles in journals, not counting duplicate publication. In a style foreshadowing the "publish or perish" mania of colleges and universities of the 1970s, Smith credited individuals' completion of work in a public fashion that rewarded the more diligent researchers and made a matter of public record the cases of dilatory progress.[38]

As Smith encouraged publication through items worked into journal articles and reports of station investigations, he took care to work out a system of crediting both senior and junior authors. His concern to grant individual credit to authors, even project assistants, contributed to a sense of high-powered intellectual demand, which was noted by a number of the veterans of this period in oral interviews compiled for this book. During the 1920s, few petroleum researchers held doctorates; apparently the only Ph.D. on the staff through the decade was F. W. Lane, who departed in 1927. The station was most successful in its recruiting of college graduate engineers and technicians, however, as the degrees of some of the staff who moved through the center indicate:

Fowler	A.B. Eng., C.E. (1915)	Stanford
Cattell	B.S. Eng. (1912)	U. of Calif.
Bennett	A.B. (1911), M.E. (1919)	Stanford
Smith, H. M.	A.B. (1921), A.M. (1922)	Clark
Smith, N. A. C.	A.B. Eng. (1909)	Clark

The research atmosphere generated by concern with publication and quality of work had several analogs to academic departments. Smith referred to staff members who moved to industry as "alumni" so often that he soon dropped the use of quotation marks. Senior authors and technicians, like senior scholars in the best academic settings, trained and "sponsored" junior specialists. Smith's policy was explicit in allowing junior researchers credit as co-authors in order to strengthen their careers and their reputations. Junior researchers sought to be placed in charge of their own projects and, after time in service, earned increased responsibility. The publication pressure mounted by Smith was well understood and, to an extent, appreciated by the researchers who came to the station through these years. Smith himself reviewed both style and content of all the items written at the station, and he was a tough critic on both counts.[39]

The sheer volume of work generated in the latter part of the 1920s makes it difficult to review each project. During 1927–1928, however, Smith assigned all work at the station to subject categories according to a project decimal code—a system that continued for nearly two decades. Different categories of projects resulted in different publication rates, as shown in

TABLE 1

Technical Work, Bartlesville, 1927–1928

Problem No.	Topic	Papers			No. Staff
		In Prep.	In Press	Pub'd.	
100	Safety Work in the Mid-Continent Fields			1	2
102	Investigation of Methods of Handling Producing Wells	1			2
103	Investigation of Mud Fluid for Oil and Gas Well Use				1
104	Application of Vacuum to Oil Wells	2			2
110	Study of Crude Petroleum	6	2	2	9
114	Treatment of Light Petroleum Distillates	1		1	2
117	Methods of Increasing the Recovery of Oil	6			6
118	Investigation of Sulphur Compounds in Crude			3	3
120	Engineering Study of the Seminole Oil Field			1*	4
121	Investigation of the Use of Gas for Lifting Oil			1*	2
122	Study of the Flow of Natural Gas through Pipelines	2	4	3	5
123	Routine Laboratory Work†		1	7	10
124	Study of Oklahoma Asphalt				2
125	Study of the Disposal of Oil Field Waters				2
126	Study of Evaporation Losses of Petroleum and Gasoline				2
	Total	24	7	20	‡

*Published in two journals.

†Publications of this section included fuel surveys, analyses of fuels and crude oils, and a paper describing a system of analysis of oil field waters.

‡Staff total ranged from 39 to 41; individual entries do not sum to the total because staff members were often assigned to two or three different problem areas.

Source: Box 224315 101.1 "History of the Bartlesville Station, 1927-28."

Table 1. As can be seen from the table, by 1927–1928 the station was involved in a wide variety of projects. Large teams of nine to ten members worked on chemical analysis of crude oil and fuels. Medium-sized teams of four to six members worked on methods of increasing recovery, studying natural gas flow through pipelines and conducting engineering studies of producing fields, as set up by Lewis and Ambrose. The other areas were characterized by small teams of one to three members. Individuals often served on several teams. There was no formally established set of research sections or divisions; specialists were assigned and reassigned as changing opportunities and needs dictated. The greatest number of publications came from the study of crude petroleum (Problem 110) and routine laboratory work (Problem 123)—the two areas to which the largest numbers of staff were assigned.[40] The gaps that appear in the petroleum problem number series in the table are because of problems taken up, then dropped, and sometimes taken up again. For example, Problem 109, "Separation of Wax from Wax Distillates," had been studied in 1925 and then dropped until 1928–1929. As new problems were added, new numbers were assigned.

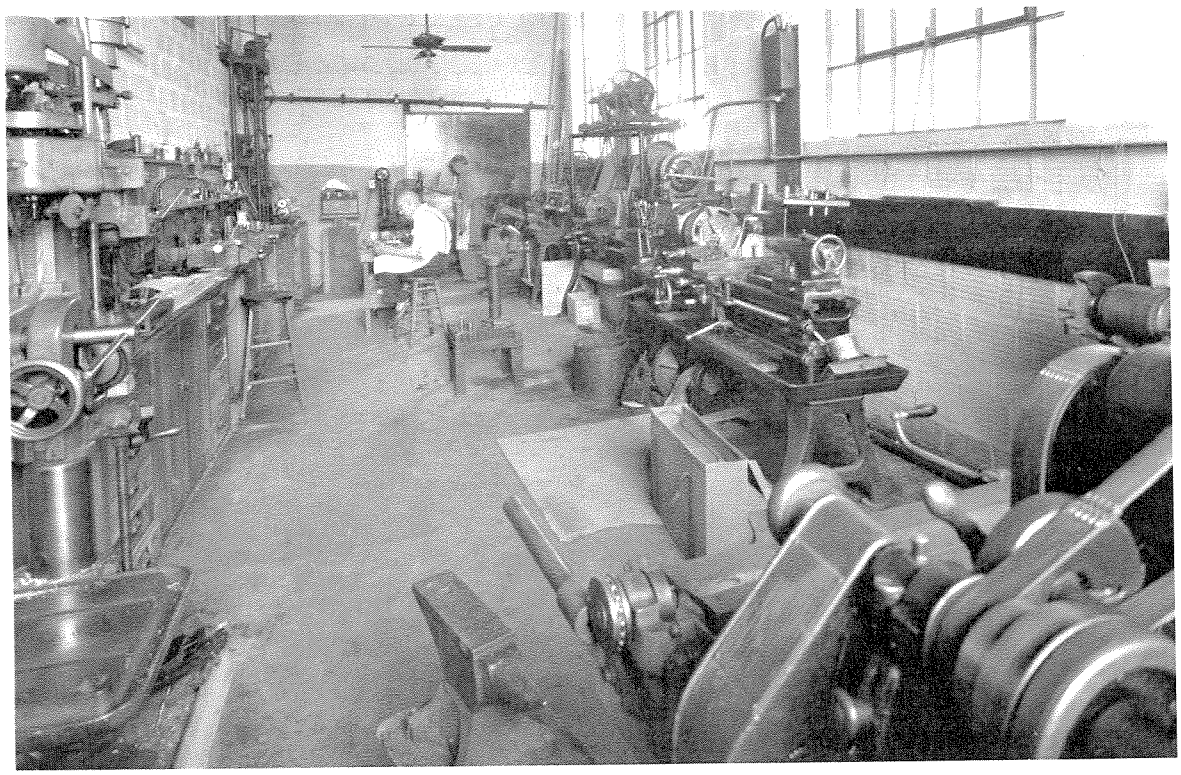
Most of the studies undertaken through the period 1926–1929 had implications for "conservation" as defined in the early years of the station; however, Smith gave less emphasis to such policy implications of his work than did his predecessors. As the laboratory became more established, there may have been less need to restate its *raison d'être* in policy terms; but it is also clear that Smith, with his emphasis on technical proficiency, assumed that good research work was an end in itself. By constant attention to the completion of work, he had established a kind of institutional momentum. He insured that work continued despite transfers, promotions, and resignations, and he saw that notes taken and partially completed by one researcher were turned over to successors and converted into publishable papers.

In any case, the philosophy of conservation as applied to oil research began to undergo a subtle change through the late 1920s, a change that would affect the station and the industry as a whole in the coming decade. As the oil crisis of the early 1920s eased with new fields in Oklahoma and California, the oil industry grew careless about production methods. In flush times, concern over vented gas, wasted potential casinghead gasoline, and methods of wringing the last cent from an oil well seemed less important. As wells came in, the profits would go to the producer who could get the leases, get in on the early production,

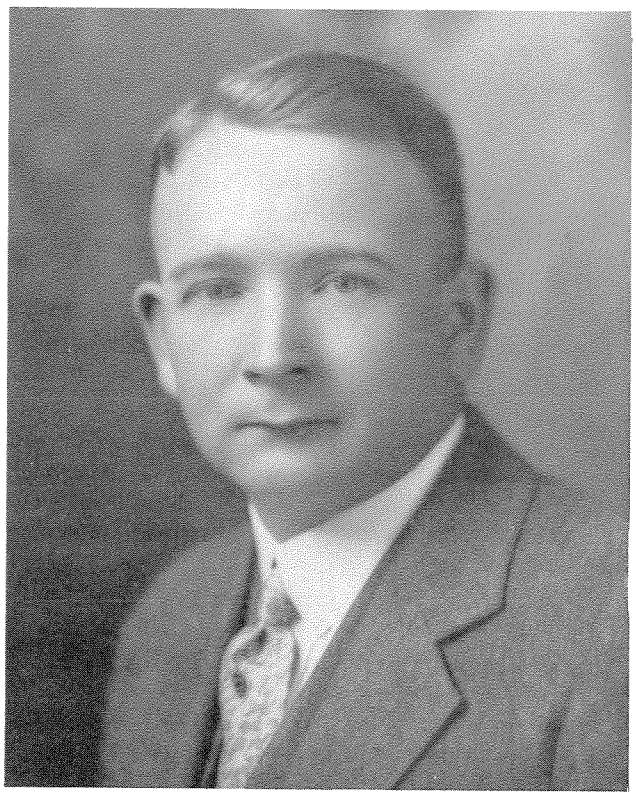
catch the crude oil under natural pressure, and then move on. Pumping wells would continue to produce revenue, but high profits went to the fast-moving wildcatter who could get in on the "plays" developing throughout the region and in California and Texas. By the late 1920s, surplus threatened to reduce the price of crude, and some producers, like Henry Doherty, anticipated the need for a rational system of production limitation. Then, within a year after the Great Crash, oil fields in east Texas flooded the market—bringing a precipitous drop in oil prices. Oil entrepreneurs struggled over the coming years to develop methods of limiting production to bring prices back up. Eventually, they would accept Doherty's reasoning, call such methods "conservation" and, like Doherty, turn to the Bureau and its stations for support. Agreements to limit production, whether voluntary or state-imposed, would face severe legal battles. And new kinds of measuring equipment and detailed information about the nature of oil reservoirs would be needed to find legally acceptable methods of limiting production and the means to enforce agreements. When their help was finally asked, Superintendent Smith and the Bartlesville station were in a good position to give it.

NOTES

1. Gerald Nash, *The United States Oil Policy* 1890–1914 (Pittsburgh: Pittsburgh University Press, 1968).
2. Conservation as a "philosophy" for the station became explicit in 1937 when the following quotation from Joseph A. Holmes, the first Director of the Bureau of Mines, was placed on a plaque over the fireplace in the station library: "True conservation is a wiser and more effective use of our natural resources."
3. General Order 224311/1990, "Explanation of General Order on the Organization of the United States Bureau of Mines Affecting the Mining Experiment Stations." Documents in the National Archives and Records Center, Fort Worth are cited here with a six-digit box number and file title or number.
4. *Oil and Gas Journal,* September 2, 1915, p. 32; December 7, 1916. Cited in Box 224315/101.1. Technical Papers #65 and 66; Bureau of Mines Bulletin #134.
5. Box 224310-1072/057.2 Reports for February through May 1918.
6. Walker A. Tompkins, *Little Giant of Signal Hill,* (Englewood Cliffs: Prentice Hall, 1964), pp. 10-11.
7. Dykema to Marshall, December 23, 1918, Box 224310/507.5/1563.
8. *National Petroleum News,* July 3, 1918, cited in Box 224315-101.1.
9. Ambrose to Hill, October 13, 1920, "Petroleum Experiment Station, U.S. Bureau of Mines, Bartlesville, Oklahoma," Box 224311/101.
10. Curtin to Lewis, November 2, 1918, Box 224311/101.
11. Lewis to J. A. McClur, February 6, 1919, Box 224310/524-1528.
12. Dykema on Osage pricing; Dykema to Cato Sells, Commissioner of Indian Affairs, June 13, 1919, Box 224311/506-11.
13. Lewis to Naramore, December 29, 1918, Box 224310/ 524-1528.
14. Lyon to Lewis, December 31, 1918 (same folder).
15. See note 11 above.
16. *National Petroleum News* publication of *Underground Conditions,* February 18, 1920; February 25, 1920; *NPN* cited in Box 224315/101.1, History of the Bartlesville Station.
17. Ambrose report, July 1920, in Box 224311/017.4. Hereafter, Ambrose Report.
18. *Ibid.*
19. Report on peg model at Ardmore, Box 224311/049 Press Notice, Hewitt Field.
20. $1,000 advanced by oil men, Box 224311/017.41.
21. Ambrose Report.
22. *Ibid.*
23. Source: Publication of report of Walters Field with Chamber of Commerce money; *ibid.* Box 224311/017.41.
24. Ambrose on shutting off water-strings by regulation. Ambrose Report.
25. Box 224310-050/Annual Report, 1920.
26. Ambrose Report.
27. Source on API "bomb." From Lowe to H. H. Hill, November 18, 1920, Box 224314/632.1; Minutes, Meeting Atlantic City, September 18, 1924; Hill to Smith October 18, 1924; Smith to Hill October 28, 1924.
28. Lane to Hill, November 18, 1924, Box 224314/632.1.
29. Box 224314/Oil Burners 720.4.
30. Pricing of Casinghead Gas, Wyoming, Box 224312/793 Salt Creek Gas Situation.
31. "Recent Activities of the Petroleum Experiment Station of Bartlesville, Oklahoma," by M. J. Kirwan read before International Petroleum Exposition and Congress, Tulsa, Oklahoma, October 8, 1924.
32. For the efforts of Hoover to establish a special brokerage rule for government with regard to business associations, see Ellis Hawley, "Herbert Hoover, the Commerce Secretariat and the Vision of an Associative State," *Journal of American History* 61 (June 1974), pp. 116-40.
33. Smith on advisory committee. Smith to Hill, January 12, 1926; Box 224315/017.401 Tough, F.
34. Hill on Folsom. Hill to Campbell et al., January 5, 1926 (same folder).
35. Campbell on committee. Campbell to Hill, January 21, 1926 (same folder).
36. Report 1925-25, "General History of the Bartlesville Station for the Fiscal Years 1925–1926"; Box 224315/101 Organization of the Bartlesville Station.
37. *Ibid.*
38. 1927–1928 Report, "General History of the Bartlesville Station for the Fiscal Years 1927–1928"; Box 224315/101 History of the Bartlesville Station.
39. Report. Interview Carlisle-Rall, 1981.
40. Box 224315/101.1 History of the Bartlesville Station, 1927-28.



In the early 1920s, equipment was meager and much of it was constructed in-house. The upper picture shows the Chemical Laboratory with Dr. F. W. Lane at left desk, John Devine in background and H. M. Thorne at right. The crude oil analysis laboratory was the forerunner of the present crude oil analysis data bank that contains 12,000 analyses of oils from throughout the world. The machine shop (lower) constructed much of the equipment used in the research projects at Bartlesville.



Interchange of personnel between Bartlesville and the Bureau of Mines headquarters in Washington and industry was frequent during the 1920s. H. C. Fowler (upper left) was at Bartlesville as a safety engineer from 1923–1928, when he moved to Washington as Chief Petroleum Engineer of the Bureau of Mines. He returned to Bartlesville in 1945 as Director and continued until 1963. R. A. Cattell (upper right) joined the Bureau of Mines in 1921 and was Superintendent of the Bartlesville Station in 1925 moving to Washington later that year. W. W. Scott (lower left) was also superintendent in 1925 and resigned to join Humble Oil and Refining Company. E. P. Campbell (lower right) was superintendent in 1925–1926 and left to join Standard Oil Company of California.