A HISTORY OF THE

HUNTSVILLE DIVISION

15 OCTOBER 1967 - 31 DECEMBER 1976

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

A History of the Huntsville Division,
U.S. Army Corps of Engineers
1967 - 1976

Prepared

by

James H. Kitchens, III

6 September 1978
HUNTSVILLE, ALABAMA

Dedicated To
Past and Present Employees of the
Huntsville Division, U.S. Army Corps of Engineers.

VITA

James Hosea Kitchens, III, was born in Austin, Texas, on 16 November 1942, the eldest son of Mr. and Mrs. James H. Kitchens, Jr. A long-time resident of Louisiana, he attended public school in Baton Rouge and Alexandria and graduated form Ruston High School, Ruston, Louisiana, in 1960. Having graduated with a B.A. in History from Louisiana Polytechnic Institute in 1965, he entered the Graduate School of Louisiana State University in the fall of that year to study European History. He earned a M.A. from L.S.U. in August 1967 and the Ph.D. in December of 1974. During 1970-1971 he was a Temporary Instructor in the Department of History, the University of Alabama in Huntsville, and in September 1975 he rejoined the Department as Adjunct Assistant Professor. In April 1978 Kitchens was appointed to the Department of History, the University of Alabama in Birmingham, as Assistant Professor of History, where he will teach Western Civilization and courses in Early Modern Europe.

PREFACE

The requirement for a history of the Huntsville Division, U.S. Army Corps of Engineers originated in a communication of 22 December 1976 from the Office of the Chief of Engineers to the Division, by which it was directed to proceed with the preparation of a history of its activities from its inception to date. The directive maintained that this history should be prepared by "a professional and competent historian," by preference from without the Division organization, and that it should generally conform to similar histories prepared or being prepared by other divisions and districts. The essay that follows is the outgrowth of this directive. During early January 1977 the Division staff conducted contractual discussions with the author toward the preparation of a history. On 11 February a "Proposal for a History of the Huntsville Division, US Army Corps of Engineers" was submitted for the Division's approval, and on 15 February 1977 Purchase Order DACA87-77-M-1096 was executed to produce the text. The Prologue was completed on 15 July 1977 and the final draft in early September 1978.

The Huntsville Division History takes its place as one of a loose series of official or quasi-official unit histories of the Corps' divisions and districts. It is intended to provide the reader with a narrative history of the U.S. Army Engineer Division, Huntsville (USAEDH) from its authorization and mobilization in October 1967 through the calendar year 1976. In conformity with the OCE directive of December 1976 and good historical methodology, I have attempted to create a document that serves official purposes but is unclassified. It is intended primarily for readers within the Corps of Engineers--especially those of the Division itself--but it is accessible to, and should be useful for, the public at large. My philosophy throughout has been to provide a lucid, reliable, and readable assessment of the Division's mission assignments and how it operated to fulfill them between 1967 and 1976.

These Division missions were diverse and complex, dictating that this essay should combine conventional chronological reporting with a topical approach in the latter sections. From 1967 until late 1971, the Division was exclusively dedicated to one mission, making a chronological treatment of the period natural. During the years 1972-1976, however, the Division was engaged in three or four missions simultaneously, and for reasons of clarity I have thought it better to adopt a topical description for each of these. Regardless of organizational form, I have tried to strike a happy medium among functional, technological, constructional, engineering, managerial, financial, and administrative elements.

The first and largest mission of the Huntsville Division was the construction of ballistic missile defense facilities in the SENTINEL and SAFEGUARD programs. Because the Division's origins were directly attributable to the BMD deployment decision of 1967, and because that mission was a highly technical one still generally mysterious to many readers, I have included a Prologue explaining something of the technical background, national policy, and climate of opionion bearing on the period up to mobilization in 1967. The ABM Treaty of May 1972 essentially foreclosed the mainstream of BMD work with the completion of only one site in North Dakota, but from about this time on the Division was required to undertake other missions in which technical and managerial expertise were at a premium. These later assignments involved contractual support for the USPS' Bulk Mail Centers, management of modernization of the facilities of the Army's munitions production base, and engineering responsibilities in conjunction with ERDA and NASA. Though short in years, a history so diverse and complex has necessitated that personalities be subordinated to a picture of the Division functioning as a unit and as a team dealing with its challenges. Nevertheless, I have endeavored to notice changes in command, fluctuation in manpower levels, shifts in key personnel, and the achievements of outstanding individuals. In all cases I have preferred a general synthesis of events to an unmanageable--and, I think, inappropriate--morass of minutiae.

The methodology employed in this study has been quite conventional, with one exception. During the spring and summer of 1977 the relevant documents were collected, surveyed, and analyzed in traditional fashion. A chapter-by-chapter outline based on preliminary research had been provided in my initial Proposal, and the composition was a matter of filling in this basic skeleton as required. The interested reader will find more information about the sources utilized in the annotation appended to the Bibliography. In addition to the usual documents, a fortuitous set of circumstances, including continuous residence in Huntsville and office space on Division premises, have also tended to facilitate intensive exploitation of oral history techniques. During the project the author was able to continuously consult with Division personnel and to question them at length on any conjectural or controversial points. The individuals contacted ran the gamut of Divisional specialities and activities; those interested will find their names and positions listed in appropriate footnotes and in the Bibliography. Their gracious and unstinting cooperation in the interview process has, I am sure, immeasurably eased the digestion of difficult documentary material and greatly enriched the finished product.

The final draft has also profited enormously from the guidance of the Division's Historical Committee. This committee was constituted on 5 July 1977, when eight members of the staff were chosen to review drafts as they were submitted and to offer critical comments or suggestions as required. To Gaines P. Gravlee, Engineering Division; Russell M. Hill, Engineering Division; James I. Hardy, Construction Division; James W. Reynolds, Procurement and Supply Division; Dewey A. Rhodes, Jr., Personnel Office; Gerald D. Dupree, Office of Comptroller; and Marie R. McGahee, Office of Counsel, I wish to extend sincerest thanks for encouragement and assistance so generously extended.

In the compilation of the manuscript I have incurred many other debts of gratitude, some of which may be acknowledged but none of which can be adequately repaid. Above all my thanks go to Public Affairs Officer, George G. Stewart, who chaired the Historical Committee, supervised the work, and remained counselor and good friend through it all. I also wish to thank Marie Spivey, Librarian of the Corps of Engineers Waterways Experiment Station, for lending documents not available elsewhere; to Col. John Lillibridge (USA, Ret.), Grand Forks Area Engineer, for furnishing a taped commentary on his experiences in North Dakota; and Marie McGahee, Office of Counsel, for help beyond the call of duty among the records of the Office.

Birmingham, Alabama
6 September 1978

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PROLOGUE

The Huntsville Division, U.S. Army Corps of Engineers, came into existence on 15 October 1967 as an organization exclusively dedicated to the task of designing and constructing the facilities needed for the deployment of the Army's SENTINEL Ballistic Missile Defense System. Unlike other Corps divisions and districts, Huntsville Division had no other military engineering functions, no civil works responsibilities, and no geographic boundaries. In this respect it was wholly unique within the Corps. Today, nine years after its mobilization, the Division remains an organization possessing qualities unparalleled within the Corps. Though its missions are now manifold, the Division's highest priority remains the design and construction of United States ballistic missile defense facilities. This and other factors have preserved its universal geographic competence. Because it was the Division's birthright, and because of the singularly complex technical, military, political, and diplomatic considerations surrounding ballistic missile defense, this Prologue offers a backdrop to the genesis of the SENTINEL System and the formation of the Division.

The United States' decision to deploy the antiballistic missile system that later became SENTINEL, the SAFEGUARD, first became public knowledge on 18 September 1967 when Secretary of Defense, Robert S. McNamara revealed it in an afternoon speech to United Press International editors and publishers in San Francisco, California. At that time the decision by President Johnson was only a few days old, and the immediacy of the presidential action put the Secretary in an awkward position. Originally he was to have presented the case for non-deployment of such an ABM system, a policy which he personally advocated and one which all Administrations had consistently followed before 1967. At the last minute, however, President Johnson had suddenly decided to go ahead with construction, and McNamara was caught in the shifting gears of policy change.[1] Hence, he devoted most of the first thirty minutes and nineteen pages of his speech to relations with the Soviet Union and to the futility of trying to build an impenetrable shield which would guarantee the protection of the American population against a massive Soviet attack. The chief difficulties with such a "thick" ABM system were not, he said, in the immense cost, but in the certainty of a corresponding Soviet reaction which would result in no appreciable improvement in security for America. "Instead," he continued, "realism dictates that if the Soviets elect to deploy a heavy ABM system, we must further expand our sophisticated offensive forces, and thus preserve our overwhelming assured destruction capability."

Then McNamara abruptly turned to the Chinese. "China has," he noted, "been cautious to avoid any action that might end in a nuclear clash with the United States -- however wild her words -- and understandably so. It would be insane and suicidal for her to do so, but one can conceive conditions under which China might miscalculate." That possibility was magnified by the recent Chinese thrust towards a workable ICBM. That being the case, "there are marginal grounds for concluding that a light deployment of U.S. ABM's against this possibility is prudent." Such a "thin" deployment would be relatively inexpensive--about $5 billion--and would be far more effective against a weak Chinese threat than a larger system would be against the Soviets. The Secretary thought there would be other advantages, too. It would reinforce the credibility of American Asian policy at a critical time by deterring Chinese nuclear blackmail. It would also have the secondary benefit of adding some defensive coverage to MINUTEMAN ICBM sites, coverage which would increase the offensive worth of these missiles. This protection could later be expanded if needed and if found feasible. Finally, such a limited ABM system would shield the United States against an accidental launch by any other nuclear power. Having reviewed these considerations, the Secretary concluded, "we have decided to go forward with this Chinese-oriented ABM deployment, and we will begin actual production of such a system at the end of this year."[2]

McNamara's September 18th speech to the journalists gave no further details about the future ballistic missile defense (BMD) sytem, possibly because few specifics had then been decided. The Secretary only hinted at cost and said nothing at all about the number of sites, the type of facilities and installations, the schedule of deployment, or the nature of the system's weapons. He had not even referred to the system-to-be by name, and as more information percolated out from official sources over the next few weeks, it was usually called the Deployment Model 1-67 System. Not until 3 November 1967 did Department of the Army General Order No. 48 officially christen the infant system SENTINEL, a name it would keep until early 1969 when a change in the mode of deployment brought with it the label SAFEGUARD.[3]

The path leading to the Johnson Administration's

decision to deploy the SENTINEL Ballistic Missile Defense System stretched back over twenty-three years to the last months of World War II and the first use of long-range rockets for military purposes. From the late 1930's German scientists and engineers in particular had been alert to the possibilities of developing large liquid fuel rockets for various uses in peace and war. With the coming of war in 1939, the military potential of rockets began to get more attention and resources, even though those designs tested showed many problems, not the least of which was a dangerously mercurial temperament. With deterioration in the Axis cause in 1943 and early in 1944, Hitler and his generals pressed hard for the employment of "miracle weapons" to save the Third Reich. Among the most novel and terrifying, though not necessarily the most effective, of these secret weapons was the V-1 "Buzz Bomb," a missile powered by a ramjet engine that began to strike England from Dutch and French bases in 1944. Because of their slow speed and raucous flight, "Buzz Bombs" were relatively easy to identify and deal with. This was not the case with the V-2, a true liquid fueled rocket with a one-ton warhead, gyroscope guidance, and a range of about 180-190 miles. The V-2 attained a velocity of several thousand miles per hour and an altitude of many miles before plunging to earth without warning. The first of these missiles was fired against Paris on 6 September 1944, and two days later London was struck by the opening explosions of an erratic but terrifying barrage of over 1,100 V-2s that would last almost to war's end. With the V-2s long range and hypersonic speed, the major characteristics of the modern ICBM vehicle were first achieved and operationally tested.[4]

The second major element in the modern ICBM also came into existence as a result of the Second World War. The first nuclear explosions used in anger at Hiroshima and Nagasaki helped end the conflict, and it did not require much imagination to envision the staggering consequences of marrying the atomic bomb to a missile delivery system. After World War II, both American and Soviet scientists were well aware that this, the "ultimate weapons system," was within reach, but creating it took more than a decade. For their part, American technical and military men basked in the luxury of a substantial technological lead and placed their reliance on the United States' nuclear monopoly and a superior strategic bomber fleet. The Soviet Union, gambling on a great leap forward to achieve parity, worked hard on building an A-Bomb and powerful load-lifting rocket motors. Both sides were faced with enormous technical obstacles: reliability, effective guidance systems, nose cone protection against reentry heating, accuracy, and above all the great weight and bulk of early warheads. Nevertheless, in August 1957, the Soviets successfully fired a rather inaccurate intercontinental ballistic missile capable of carrying a single nuclear bomb. The first American ICBM, the ATLAS, flew four months later. Thus the contemporary ICBM age can be said to have fully dawned by the beginning of 1958. Later developments such as solid fuel boosters, launching silos, and mutiple warheads can be considered as refinements in the state of the art rather than as major breakthroughs.

It is axiomatic in military history that as soon as a new weapon comes into the hands of the offense, the search for protective countermeasures begins on the part of the defense. This was as true of the ballistic missile as of the sling, the crossbow, the flintlock, or the submarine. Even before V-2 missiles began to fall, Allied intelligence officers were busy trying to puzzle out the nature and possible uses of the ominous unidentified cigar shapes on their aerial photographs of Peenemunde and other sites. The mysterious double explosion of the first missiles and the subsequent collection of bits and pieces made the nature of the V-2 perfectly clear, while at the same time driving home the apparent hopelessness of trying to cope with the hypersonic speed and unheralded arrival of the missile. In 1944, for example, the General Electric Company was awarded a contract under Project THUMPER to research and develop a high altitude antiaircraft missile that would be effective against the V-2. G.E.'s 1945 report realistically concluded that defense against ballistic missiles by such means was beyond the scope of contemporary technology. The Allies' initial helplessness remained until war's end, the common opinion among the learned being that the only defense was capture of the launching sites themselves. This proved true: the first ballistic missile defense was, in fact, nothing more than the seizure of German launching facilities.[5]

The situation prevailing at the end of World War II remained essentially unchanged for a decade. Despite the seemingly insurmountable problems surrounding early missile defense, a search for solutions began with the end of the war and continued at a snail's pace during the 1940's and early 1950's. In large measure, the progress that was made during this period was theoretical and conceptual, since the United States was still absorbing the lessons of the German experience and accumulating basic data about the

behavior of radars, rocket engines, airframes, guidance systems, fuels, and the environment of the exosphere. In these areas American expertise was considerably aided by expatriate German scientists and engineers brought to this country by Operation PAPERCLIP; with their help, surplus V-2s and later designs such as REDSTONE were test flown at White Sands, New Mexico, to provide the United States with the necessary elements of advanced rocket technology.

Perhaps the major development in ballistic missile defense during the late 1940's was the realization that the "collision intercept" philosophy represented by far the most promising solution--probably the sole one--for stopping incoming missiles. By the end of World War II, the use of missiles against fast high flying aircraft was practical, and since this antiaircraft scenario most closely resembled the requirements of any ballistic missile defense system, BMD thinking quite naturally gravitated towards it. In 1945, the U.S. Army placed extremely important milestone contracts with Bell Telephone Laboratories (BTL) and Western Electric Company (WECo) for design of high altitude antiaircraft missiles and control mechanisms under the label Project NIKE. The original NIKE contracts were renewed throughout the 1950's, resulting in the production and deployment of NIKE-AJAX, a radar-directed antibomber missile intended for strategic defense of the United States. The success of NIKE-AJAX promoted an improved second-generation weapon called NIKE-HERCULES, similar to AJAX but nuclear tipped. Though limited to countering jet bombers, NIKE-AJAX and -HERCULES production and deployment was a significant step forward towards a workable defense against missiles because experience with these systems produced a wealth of information about the operational potential, as well as the limitations, of defensive missiles. And while the Army was developing its NIKE-AJAX and -HERCULES, the Air Force and the Navy were also engaged in rival GAPA, BOMARC, and TALOS projects. This interservice competition probably stimulated the overall growth of missile technology, but it also spawned duplication of cost and effort. In 1958 Secretary of Defense McElroy directed that in the future the Army would have charge of most aspects of air defense missiles.[6]

Serious efforts to turn antibomber systems into antimissile systems were greatly stimulated during 1954 and 1955 when it became evident that not only did the Soviets possess the A-Bombs, but that they were also rushing development of an intercontinental missile to deliver it. The implications of Soviet progress seemed to be amplified by American experiments with the H-Bomb, particularly the "Shrimp" shot of March 1954. Benson Adams, expert in ballistic missile defense, notes that this explosion "completely revolutionized ICBM design, for it showed that the [H-Bomb] warhead could be married to the ICBM without the necessity of designing the missile and its huge propulsion system around a large unsophisticated (A-Bomb) warhead."[7]

Confidence in American security began to erode under the impact of improving Soviet capability and loss of the nuclear monopoly, and in March 1955 the Army asked BTL to re-examine the feasibility of missile defense in the light of recent developments. After eighteen months of study, BTL reported in October 1956 that missile defense was now within the realm of possibility, and in February 1957 the Army Rocket and Guided Missile Agency issued prime research and development contracts to BTL and WECo, with subcontracts to Douglas Aircraft, RCA, and Goodyear Aircraft for basic research on a missile defense system. Drawing on their past experience in the field, these companies returned a design proposal for the first true antimissile missile system. It was to be called NIKE-ZEUS after the Greek deities of Victory and the Chief of the Olympians. The ZEUS proposal was accepted, and in 1958 the Ordnance Technical Committee of the Army authorized ZEUS as a full-scale development program. Project ZEUS would span the next four years and bring forth the world's first workable ABM system.

The three principal elements in the NIKE-ZEUS System were generally the same as those of all future BMD systems down to and including the SAFEGUARD of 1969: radars for target acquisition, tracking, and antimissile guidance; a computer for data processing; and antimissile missiles for interception and destruction. In the operation of the mature ZEUS, a long-range ZEUS Acquistion Radar (ZAR) continuously scanned the heavens and first detected incoming objects several hundred miles out. A Decoy Discrimination Radar (DDR) was then designated to track the objects, feeding information into an associated computer which tried to determine which of the objects were genuine warheads and which were inert dummies or decoys. Target Tracking Radars (TTR) then automatically took over and continuously furnished precise trajectory data into a second computer, which worked out a projected intercept point. When within range, a killer ZEUS would be fired, to be command guided out to its target by a separate Missile Tracking Radar (MTR). The mastermind of the system was the Target Intercept Computer (TIC), which solved guidance and control

problems by digesting information about incoming objects and feeding it back to the ZEUS as soon as possible. ZEUS itself was a third generation antiaircraft rocket whose booster and two stages gave its nuclear punch a reach of 100 miles.[8]

As might be expected of any such pioneering effort, the ZEUS System had limitations. It was complicated, and all four of its radars were mechanically slewed. Like spectators' heads at a tennis match, each antenna had to be physically rotated to follow an object. Because of these design limitations and others, one set of tracking radars could follow only a few reentry vehicles at a time, generating a severe "traffic handling" problem. ZEUS' only answer was to use several sets of radars and computers to control one battery of two dozen missiles. Nor could the ZEUS radars discriminate between decoys and armed warheads until the slowing effect of denser air in the lower atmosphere had helped sort out heavy projectiles from lighter ballons, chaff, fragments, tankage, and other penetration aids. Thus the system was prone to overwhelming saturation by simultaneous threats. By the time ZEUS' computer was able to tell foe from fake, the intercept range had become too short to prevent the defense from being hoist with its own petard.

Despite all these drawbacks, the ZEUS System did work for one warhead at a time. This was shown on 19 July 1962 when a ZEUS fired from Kwajalein Island actually intercepted and theoretically destroyed an ATLAS-D ICBM fired from Vandenburg AFB, California, 4,800 miles away. Before the end of 1962, two more ICBM's, one of which employed decoys, had been intercepted. These tests were milestones in the evolution of ballistic missile defense, for they convincingly demonstrated what some skeptics had doubted, that "a bullet could hit a bullet."

Still, the ZEUS System existing in 1962, while workable, did not yield a performance commensurate with the estimated $10 to $14 billion cost of production and deployment to guard twenty-five cities.[9] Thus, with the concurrence of the Congress, Presidents Eisenhower and Kennedy and their scientific advisers refused to ask for ZEUS production. Instead, they began a traditional American BMD policy of funding more research and development while resisting requests for deployment. In retrospect, then, the real historical meaning of ZEUS lies not in its operational record but in the progeny which it spawned. For in ZEUS one can clearly see the granddaddy of SENTINEL -- all the basic requirements for a BMD system were there except protection against nuclear weapon effects, and even such terminology as "ZAR" closely resembled the later SENTINEL'S "PAR." What ZEUS needed most in 1962 was further improvement and simplification in its radars, that is, a combination of target tracking functions with interceptor flyout guidance to increase the discrimination, speed, and reliability of the whole system.[10]

The NIKE-X System which followed ZEUS after 1962 went far towards remedying its predecessor's shortcomings by introducing a vastly improved radar and a combination of two missiles intended to overcome the deficiencies of ZEUS alone. Under Project NIKE-X, Sylvania researchers developed a multiple function radar system which could discriminate and track incoming enemy missiles while also tracking and steering outgoing interceptors. These advanced radars substituted a new concept called the phased-array technique for the old heavy and slow mechanically slewed dish antennas hitherto employed. Phased-array radars generated many radar beams simultaneously and electrically shifted them, enabling the device to scan the horizon in a matter of microseconds. The invention of phased-array was a quantum step forward, because at one fell swoop it immensely increased the radar system's discrimination ability while making it possible to house the antennas and attendant equipment in a hardened concrete building, the ground plane of the antennas forming in effect part of the flat building face. In this way phased-array solved the traffic handling problems of ZEUS and allowed increased protection against nuclear attack.

The second major addition under NIKE-X was a short-range but ultra-high acceleration missile called the SPRINT. SPRINT was a solid fuel rocket built by Martin-Marietta capable of reaching its terminal velocity of many thousand feet per second a few moments after popping out of its underground silo launcher. It had a range of aboute twenty-five miles. The weapon was complementary to the new radars in enhancing the performance of the entire system. Extensive testing over the Pacific during the ATLAS program had shown that atmospheric slowdown filtering was the most effective means for eliminating decoys from a flock of targets, and with SPRINT could be withheld until after enemy objects reentered the atmosphere, where the denser air acted as a natural and unavoidable brake on decoys, giving them a different flight path and thus quickly unmasking their counterfeit nature.

To do NIKE-Xs thinking, a highly reliable ultra-high speed data processing system was a must. Yet the performance parameters of such a computer had

always been regarded as formidable, if not impossible. Required was a multi-processor unit that could handle 30 million instructions per second with a failure rate of less than eight "fits" in the basic logic circuits per billion hours of operation. No commercial computer available or planned could approach these performance and reliability criteria, but in 1963 BTL enlisted the help of Sperry Rand Corporation to tackle the problem. By 1967 the prototype of such a UNIVAC computer was operating at BTL's Whippany, New Jersey, laboratory, with plans afoot to install a second model at Meck Island in the Pacific.

As developed by 1966 the NIKE-X System had two phased-array radars, one a very powerful Multifunction Array Radar (MAR) for long-range detection, acquisition, and discrimination, the other a short-range Missile Site Radar (MSR) for close-in conduct of the battle with ZEUS and SPRINT missiles. The only holdover from NIKE-ZEUS was the DM15c ZEUS missile, and by 1967 this too began to be phased out in favor of the DM15X2, later called the SPARTAN. SPARTAN was a Douglas-built two stage rocket with a range of 400 miles, a three-to-five megaton warhead, and a capability for exo-atmospheric intercepts. To take full advantage of SPARTAN's range, in 1967 the MAR was in the process of being refined into the Perimeter Acquisition Radar, or PAR, for surveillance up to 1000 miles. Finally, by 1967 thought was being given to putting all radars in hardened concrete buildings for protection from nuclear effects. Research on this and other aspects of NIKE-X facility construction was going on at the Advanced Technology Branch, Military Construction Engineering Division, of the Army Corps of Engineers in Washington, D.C., and the NIKE-X Branch, Engineering Division, of the Mobile District. Though still embryonic, the NIKE-X of early 1967 employed the modus operandi and all the necessary technology that became the SENTINEL System a few months later.[11]

The brief description of the NIKE-X just given indicates that by 1967 considerable technological progress had created the possibility of a feasible, rather than a merely workable, BMD scheme. The repercussions of this change were very great, because the technological accomplishments of NIKE-X expanded the questions surrounding BMD from the narrow realm of technical and military considerations into political, fiscal, social, and diplomatic areas. As NIKE-X showed its practicality, the Johnson Administration more than ever had to weigh what variety and combination of BMD ought to be deployed, how to integrate any type of BMD into the overall national defense posture, what the cost would be, and the possible effects of various deployments on American-Soviet relations. And it had to assess these factors amid growing American involvement in Vietnam, heightened tensions in the Middle East, domestic discontent, the emergence of a Chinese nuclear threat, and substantial improvement in Soviet strategic capabilities. In short, the big BMD question became "should we deploy?" rather than "can we deploy?". It was not an easy question to answer.

Production and deployment of the NIKE-X System had been pondered at the highest governmental levels for several years prior to the favorable decision of 1967. In the early 1960's, the Pentagon had usually recommended deployment, but Presidents Kennedy and Johnson consistently resisted it, believing that the estimated $30 billion cost did not promise a commensurate dividend in security against a sophisticated Soviet attack. They reasoned that even though NIKE-X had good discrimination and combat qualities, a massive attack would saturate the system, permitting enough warheads to get through to destroy too much of the population. That possibility was made even more probable by the predicted coming of multiple independently-targeted reentry vehicles, or MIRV's, then creeping up the near horizon of reality A MIRV gave each attacking missile a shotgun effect, multiplying its threat three to five times at little extra expense. An attack by MIRVed missiles would be able to saturate all but the heaviest BMD systems. The cost of a MIRV-proof net would be enormous, and it would have to come out of other defense needs and domestic programs. And even if such a very heavy defense were employed, the Soviets could enlarge their missile strike force to overcome it at relatively little cost. The United States would have to keep up by enlarging her forces, and the arms race would be accelerated at the expense of detente. The knowledgeable called this "the destabilization factor."

Until 1964 American policy had only to reckon with a Soviet threat, but in October of that year the international situation grew more complicated with the entry of China into the nuclear club. Though it would obviously be some time before a Chinese threat could materialize--she then had no missiles and few bombs--no one could accurately forecast the rate at which China could build an ICBM force. Nor could even the most experienced China-watchers tell how much of her sabre-rattling was genuine and how much bombast. As far as BMD policy was concerned, this meant considering construction of a "thin" network to handle any small-scale, irrational attack that might come about in the near future. Consquently, early in

1965 the Department of Defense began studying ways to counter the "Nth Power" threat by assembling various combinations of off-the-shelf NIKE-X components into an area defense system intended to put an umbrella over U.S. cities. The attractiveness of such a "thin" Chinese-oriented system grew after May 1966 when the Chinese exploded their first H-Bomb and grew still more after late 1966 when their first primitive nuclear-armed missile flew. An, interest in BMD was further heightened after 11 November 1966 when it was revealed that the Soviet Union was deploying a BMD of its own around Moscow. No American action was immediately forthcoming during 1966 to counter these changes on the international scene. But a strong sense of urgency about a BMD decision was building, sharpened by current Soviet moves and improvement in China's arsenal.[12]

While the major American BMD effort remained devoted to research and development until 1967, some preparation for the eventuality of deployment had been undertaken. Throughout 1964, 1965, and 1966, the NIKE-X Project Office at Redstone Arsenal worked up a series of contingency plans and understandings with BTL and WECo for contracting mass production of NIKE-X weapon systems parts. On 5 June 1965, the Department of the Army approved a NIKE-X Project Office plan to manage the deployment of a NIKE-X System. The plan envisioned a NIKE-X System Manager at Department of the Army level who would execute a deployment order through a sizeable NIKE-X field organization under his direct command, with the assistance of major Army commands and agencies. Implementation of the Army's 1965 plan began in March 1966 with the assembly of a personnel cadre. In October 1966 Lt. Gen. Austin W. Betts was appointed to act as NIKE-X System Manager in addition to his other duties. About the same time, the NIKE-X Project Office and the NIKE-X Engineering and Service Test Office of the Army Materiel Command were placed under the operational control of the System Manager to assist him in the field. [13]

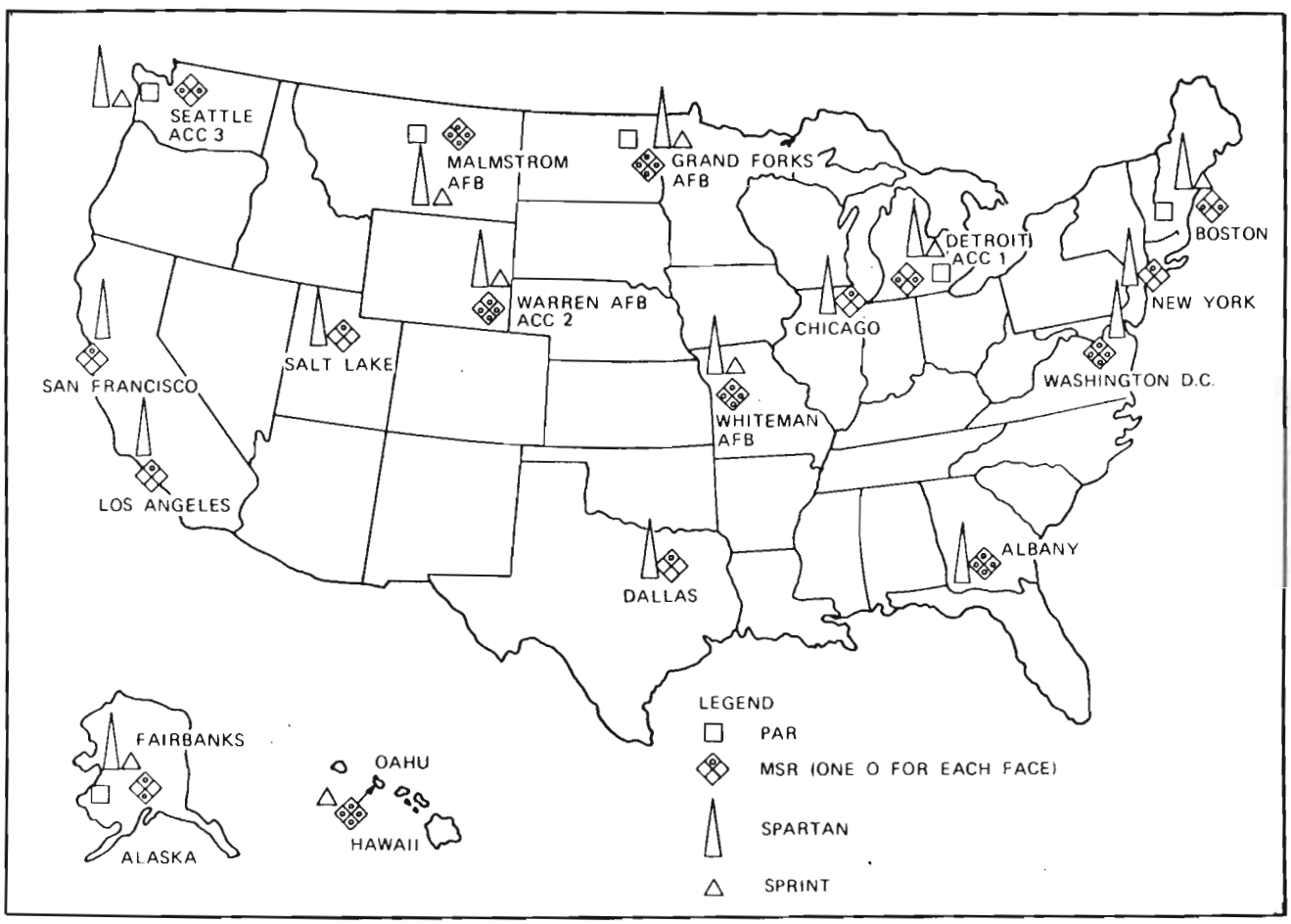
One of the first actions of the new System Manager was to prepare and issue Letters of Instruction to each of the major Army commands and agencies which could have a role in any future deployment. One of these directives went to the Army Corps of Engineers on 2 December 1966, assigning the Corps the heavy responsibility for design and construction of NIKE-X facilities should the system be deployed. The Chief of Engineers began working up a plan to mobilize a special new Corps of Engineers NIKE-X Division to carry out his potential mission. The plan, published in May 1967 as the "Corps of Engineers NIKE-X Mobilization Plan," provided a complete initial game plan for mobilizing a NIKE-X Division to design and construct the facilities required in a NIKE-X deployment. The Engineers' NIKE-X Division was to serve the NIKE-X system Manager's mission exlusively. In fact, when SENTINEL was ordered deployed in the fall of 1967, the NIKE-X Division immediately became the Huntsville Division. [14]

A second action of General Betts after December 1966 was to work up a series of repesentative deployment models, thereby providing a common basis for planning by all agencies. The first deployment model proposed was "Plan 1-67 Area/Hardsite Defense" comprised of a mix of weapons and facilities keyed to a "thin" area defense aimed primarily at a Chinese threat and having a $5 billion cost ceiling. The deployment was to be completed in fifty-four months, which meant using off-the-shelf NIKE-X parts. During the first six months of 1967, BTL and WECo evaluated this model and presented several interim reports to Secretary McNamara. On 5 July 1967, the Secretary of Defense got a final briefing on this deployment model, as well as on alternatives which would provide defense against more sophisticated Soviet threats, including the Fractional Orbit Bombardment System known as FOBS. Following the briefing, McNamara asked for a thirty day study of the emerging Chinese Communist threat and of an ABM deployment to counter it that would also incorporate modular growth options for Soviet ICBM's and SLBM's. Dr. John Foster, Director of Defense Research and Engineering, established a committee known as the "Montgomery Committee" which held its first meeing on 11 July. On 15 August, the Montgomery Committee returned a generally favorable report indicating that what was then being called "NIKE-X DEMOD 1-67" consituted an adequate basis for proceeding with deployment. [15]

About this time a series of events on the international scene won the case for commencing production of NIKE-X. In June 1967, the Chinese renewed their nuclear program with another H-Bomb shot, while in the Middle East the Soviet Union gave the Arab side heavy logistical and moral backing in the Six Day War. Throughout the year both the Chinese and Soviets had vociferously denounced the American buildup in Vietnam. Perhaps in part because of the Six Day War, perhaps because of Vietnam, the Soviets showed themselves reluctant to talk about arms limitations in general and BMD in particular, despite several invitations from the Johnson Administration

to do so. This Soviet posture was further emphasized during and after the Glassboro Conference of June 1967, where Premier Kosygin took a "hard line" against limited arms talks with the United States. On 8 September 1967, Secretary of State Dean Rusk gave the Soviet Union a last chance notice to either take up negotiations about missile defense or face the consequences of American deployment of a BMD. When no favorable response was forthcoming within the next eight or ten days, President Johnson decided to approve deployment of a ballistic missile defense system. On the spur of the moment, Secretary of Defense McNamara was handed the task of announcing the decision to the journalists and publishers in San Francisco.[16]

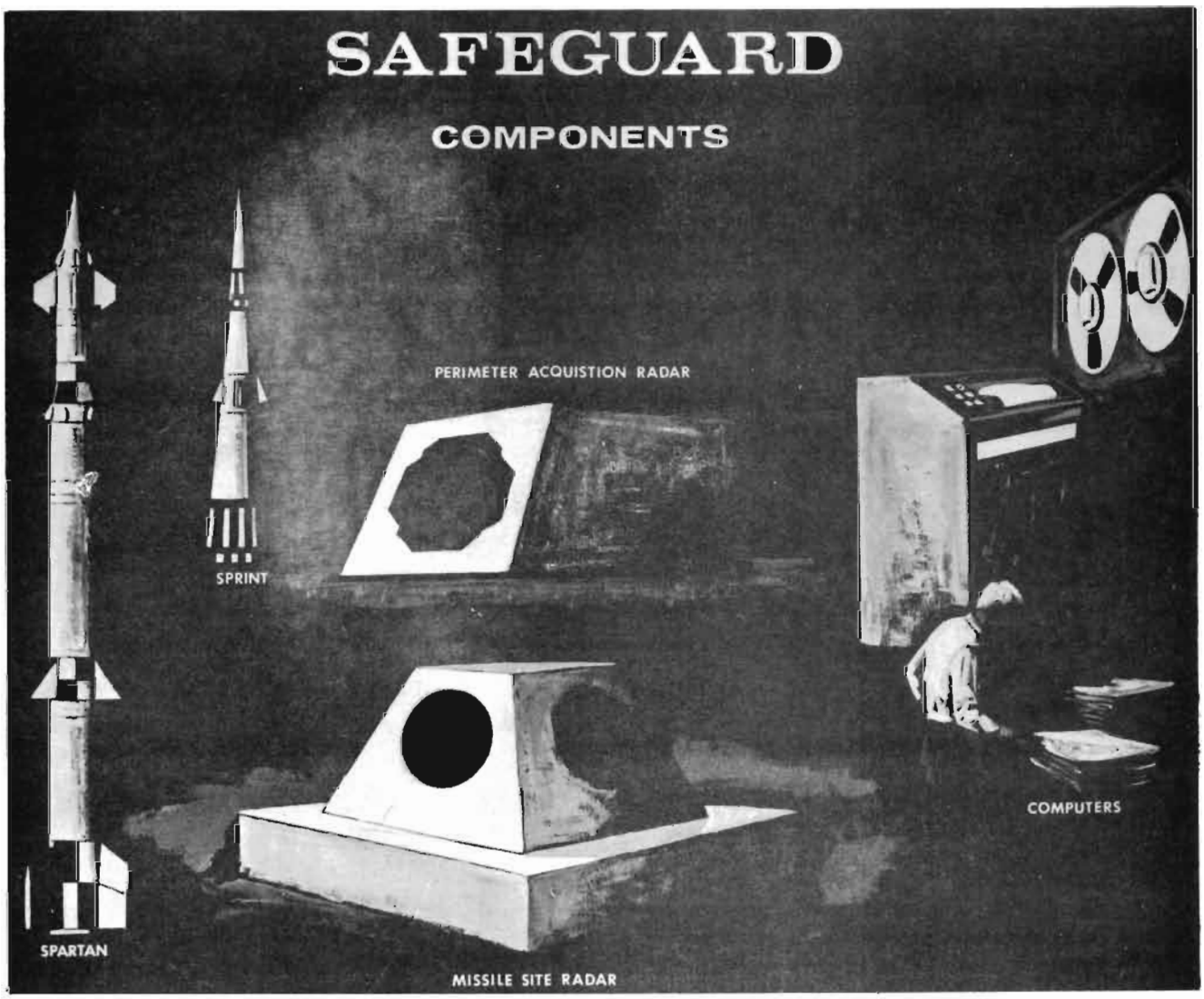
The placement of facilities in the SENTINEL System deployment unveiled by Secretary McNamara was never wholly revealed to the public, and in 1977 the details still remained locked in classified papers. Nevertheless, from later evidence, especially BTL's **ABM Research and Development at Bell Laboratories: Project History** and Congressional testimony given by Secretary of Defense Melvin Laird in 1969, the outline of DEMOD 1-67 projected by the Joint Chiefs of Staff in late 1967 can be deduced.[17] SENTINEL was to be a "thin" area defense system providing good protection for American cities and ICBM sites against Communist Chinese attack or an aberrant launch by any nuclear power. By adding more radar faces and missiles to certain installations, the System apparently could have been expanded to partially cope with Soviet ICBM's and/or submarine launched missiles.[18] The completed System would consist of seventeen sites: fifteen in the forty-eight contiguous United States and one each in Alaska and Hawaii. Five PAR's, each with one northward



pointing face, would be spread across the northern tier of states facing the Chinese ICBM threat corridors with a sixth PAR planned for Fairbanks, Alaska. Each of these six PAR's would also have a MSR associated with it; eleven other sites would have a MSR only. The Albany, Georgia; Washington, D.C.; and Oahu, Hawaii, MSR's plus the four MSR's deployed in the midwestern MINUTEMEN fields would each have four faces to provide 360-degree coverage. The remaining ten MSR's would have fewer faces. All of the sites except Hawaii would share a total inventory of 480 SPARTAN and 192 SPRINT missiles; the Hawaiian battery would have twenty-eight additional SPRINTS but no SPARTANS because of the small area to be protected. Certain sites would have SPRINTS located in Remote Launch Sites (RLS's) fifteen to twenty miles distant from the MSR to shorten flyout time and widen coverage. The combined oval "footprints" of defended areas encompassed the entire continental United States and most of Alaska and Hawaii.

It should be noted that the SENTINEL deployment described above would have offered some protection from Soviet attack, and from the beginning some opponents concluded that it was the opening wedge of a denser shield against the Soviet Union. An additional noteworthy feature of the deployment was that it was apparently scheduled to go forward as a whole, rather than to follow a step-by-step gradual enlargement contingent upon subsequent Soviet or Chinese moves. This approach would be revised with the SAFEGUARD program of 1969.

Weapon system in the SENTINEL were to be based on developed NIKE-X components, with PAR and MSR radars housed in hardened concrete structures close by.[19] Six powerful PAR's would give picket line



detection and discrimination out to about 1000 miles, but the PAR's were not to be armed with missiles. Instead, their data would be sent through redundant circuits to a nearby MSR, there to be integrated with that station's picture. Each MSR would be a tactical nerve center equipped with data processing equipment fed by its short-range radars, augmented in the six northern MSR's by input from nearby PAR's and each MSR could utilize the data thus gathered to fight a regional anti-ICBM battle with SPARTAN and SPRINT missiles. On a nationwide scale tactical BMD decision, directed by the National Command Authorities (civilian executive and Joint Chiefs of Staff), would be coordinated and orchestrated from Army Air Defense Command Headquarters located deep within Cheyenne Mountain near Colorado Springs, Colorado. Here a national battlefield picture could be maintained and analyzed at all times by means of data links to a central computer display observed by command staff. Training for SENTINEL duties would take place on actual equipment and simulators at a Central Training Facility collocated with the U.S. Army Air Defense School at Fort Bliss, Texas.[20]

At its inception the SENTINEL was a highly complicated and sophisticated piece of military engineering, undoubtedly the most sophisticated and complicated since the MANHATTAN Project of World War II. Even if its individual components and facilities had been completely proven, the complexity of the system would have aroused some concern about whether it could be tuned to work in concert. But in September 1967, SENTINEL's workability was more conjectural because every major weapon system element was still in a stage of research and development, and some parts had not even reached that stage.[21] A prototype MSR installation, for example, was then being built at the Kwajalein Missile Range, but it was not initially "powered-on" until 18 May 1968. Even so, this prototype had only two faces, and because its building was "soft," it did not fully reproduce an operational setting. A MAR-I radar had been well tested at White Sands, but it had never been hardened nor harmonized with the MSR at Kwajalein. Experience with NIKE-X had shown that commercial computers were inadequate for BMD purposes, and it was envisioned that SENTINEL would enjoy the software and hardware of a specially developed Central Logic and Control System from BTL. But only a laboratory prototype Central Logic and Control System existed in 1967. Finally, neither SPRINT nor SPARTAN were yet perfected: their NIKE-X antecedents had worked well, but research and development versions of the SENTINEL-type missiles were just being flight tested in 1967 and did not achieve their first intercepts until 1970. Finally, no experience had been obtained with operating or maintaining a nationwide network of BMD facilities.[22]

Reaction to the decision to deploy this embryonic SENTINEL was almost uniformly hostile outside the United States. Communist powers predictably denounced the System as another expression of imperialist warmongering, while even the British were miffed at not being consulted. The Canadian government refused to participate in the projected system, even though it was to be tied into the North American Air Defense Command. Within the United States, reaction varied from warm approval in some quarters through wide indifference to overt opposition. Mixed reactions were clearly evident in the Congress, where Senators Stennis, Anderson, Tower, and Hickenlooper applauded the decision while Senators Church, Clark, and Fullbright opposed it. Some considered the decision on its merits, but in the minds of many Americans, both within governmental circles and without, the question of BMD could not be separated from emotions about the broader problems of Vietnam, defense spending, or the influence of the so-called "military-industrial complex" in American life. In September 1967, the country as a whole was beginning to manifest deep-rooted divisions and gnawing antagonisms over many areas of public policy, especially foreign policy as exemplified by the Vietnamese War. Insensibly, the news of SENTINEL merged with greater controversies rivening American life, so that the infant BMD was born under a cloud of acrimony that gradually grew darker and stormier as its deployment matured.[23]

PROLOGUE FOOTNOTES

[1]This is the thesis of Benson D. Adams as presented in **Ballistic Missile Defense** (New York: American Elsevier, 1973), p. 161, n. 18. Adams' study is a scholarly and unbiased examination of the history of ballistic missile defense in the United States with emphasis on the Governmental policy associated with it until 1973. It should be the first reference for those seeking an overview of missile defense during the period down to and including the Modified Phase II SAFEGUARD of 1972.

[2]U.S. Department of Defense News Release No. 868-67, "Address by Honorable Robert S. McNamara, Secretary of Defense Before United Press International Editors and Publishers, San Francisco, California, September 18, 1967."

[3]USAEDH-PAO, "Historical Summary FY 1968," Vol. II, Exhibits of Supporting Documents, pp. 48-49. Henceforth cited as USAEDH-PAO, "Historical Summary."

[4]For the history of the German military rocket program during World War II, see David Irving, **The Mare's Nest; the German Secret Weapons Campaign and Allied Countermeasures** (Boston: Little Brown, 1965); James McGovern, **Crossbow** and **Overcast** (New York: W. Morrow, 1964); and Ernst Klee and Otto Merk, **The Birth of the Missile,** trans. T. Schoeters (New York: E.P. Dutton, 1965). A brief summary which includes performance of the V-2 rocket is in U.S. Senate, Preparedness Investigating Subcommittee of the Committee on Armed Services, **The United States Guided Missile Program,** 86th Cong., 1st Sess., 1959, pp. 5-6.

[5]Adams, **Ballistic Missile Defense**, pp. 17-31.

[6]**United States Guided Missile Program,** pp. 6-14, 62-63, 96.

[7]Adams, **Ballistic Missile Defense,** p. 11. Adams goes on to observe that the Soviets followed just the opposite policy than did the United States, that is, from the beginning, they farsightedly developed large booster rockets to cope with heavy loads and later reaped the benefits in terms of large military payloads and in space exploration.

[8]BMDSCOM, **ABM Research and Development at Bell Laboratories: Project History** Whippany, New Jersey: Western Electric Co., October 1975), pp. I/1-I/36. This valuable volume is a detailed unclassified history of BMD research and development of antimissile systems carried on by Bell Laboratories and Western Electric Co. from 1955 through 1975. It was prepared by Bell Laboratories on behalf of Western Electric Co., Whippany Road, Whippany, New Jersey, for the U.S. Army Ballistic Missile Defense System Command (BMDSCOM) under contract DAHC60-71-C-0005 and presented in October 1975. The bibliography contains lists of secret materials from which the study was made.

[9]Adams, **Ballistic Missile Defense,** p. 53. The figures are 1962 dollars.

[10]Ibid., pp. 24-58; U.S. Department of Defense News Release 188-69, "Ballistic Missile Defense--History Fact Sheet (March 14, 1969)"; U.S. Army SENTINEL System Command, "NIKE-ZEUS & NIKE-X Development," p. 1.

[11]Adams, **Ballistic Missile Defense**, pp. 63-141; SENSCOM, "NIKE-ZEUS & NIKE-X Development," p. 2; DOD News Release 188-69, "BMD History Fact Sheet (March 14, 1969)."

[12]Adams, **Ballistic Missile Defense,** pp. 125-141.

[13]SENSCOM, "NIKE-ZEUS & NIKE-X Development," pp. 3-4.

[14]OCE, "Corps of Engineers NIKE-X Mobilization Plan," May 1967, pp. 1-2.

[15]Adams, **Ballistic Missile Defense,** pp. 130-142, 145-161; BMDSCOM, **Bell ABM Project History,** pp. I/44-I/45; SENSCOM, "NIKE-ZEUS & NIKE-X Development," pp. 3-4.

[16]SENSCOM, "NIKE-ZEUS & NIKE-X Development," pp. 3-4; Adams **Ballistic Missile Defense,** pp. 145-161.

[17]See testimony by Secretary of Defense Melvin Laird in the House of Representatives, Hearings Before Subcommittee of the Committee on Appropriations, **SAFEGUARD Antiballistic Missile System,** 91st Cong., 1st Sess., 1969, pp. 24-25 and **BMDSCOM, Bell ABM Project History,** pp. 3/1-3/10.

[18]The principal question surrounding the configuration of proposed SENTINEL facilities concerns the number of faces required for the PAR at Boston, Massachusetts. In 1977 the author was unable to obtain definitive information concerning the possibility that certain PAR's, Boston among them, were to have a subordinate face oriented towards Soviet submarine launched missiles. A changeover from a single face to a two face PAR may have been ordered during the course of design in 1968. The question of PAR configuration is more fully discussed in Chapter I.

[19]The degree of hardness, generally measured in terms of pounds per square inch of atmospheric "overpressure" produced by the blast, has never been declassified. The principal factors in calculating the overpressure are size of the warhead(s) exploded, distance from the target, and above-ground distance of the explosion.

[20]BMDSCOM, **Bell ABM Project History,** pp. 3/1-3/10; DOD News Release 188-69, "BMD History Fact Sheet (March 14, 1969)."

[21]USAEDH, "Anti-Ballistic Missile Engineering Criteria Manual for Tactical Site Selection," November 1967, includes in Appendix III some interesting early tentative designs for hardened NIKE-X facilities such as a two faced MAR Building with separate transmitting and receiving faces and a four faced MAR Building.

[22]DOD News Release 188-69, "BMD History Fact Sheet (March 14, 1969)."

[23]Adams, **Ballistic Missile Defense,** pp. 177-195.

CHAPTER I

THE SENTINEL PROGRAM

Following President Johnson's decision of September 1967 to deploy the SENTINEL Ballistic Missile Defense System, there were two primary tasks which had to be carried out to bring BMD into reality. The first of these tasks was the completion of research and development of SENTINEL's weapon system, especially the PAR, the missile interceptors SPARTAN and SPRINT, and the Central Logic and Control System master data processing equipment. In the fall of 1967 these components were still in a formative stage, but work was already well underway by prime contractors Bell Telephone Laboratories (BTL), Western Electric Company (WECo), McDonnell-Douglas, and Martin-Marietta, together with a host of subcontractors to perfect them. For the most part, it was a matter of extending previous NIKE-X contracts in order to adapt proven technology to SENTINEL's requirements.

The second major thrust following the SENTINEL decision was the design and construction of hardened facilities and attendant support structures to house the weapon system and its operators. It was logical that this mission should have been assigned to the U.S. Army Corps of Engineers, a branch of the Army organized in 1775 to provide for the service's military engineering needs. During the American Revolution, a handful of French and American engineers supervised the building of fieldworks, an effort which culminated with the victorious siege of Yorktown. From these beginnings in the Revoluntionary period, Army engineers were actively involved in nation building throughout the eighteenth and nineteenth centuries. Engineers in uniform helped explore and chart the West; laid out canals, roads, and railroads; made navigational improvements in streams and rivers; and, towards the end of the 1800's, began the first civil works intended to tame the Mississippi River. The Corps' extensive civil undertakings continued in the twentieth century with such projects as the Panama Canal and the Jadwin Plan for further Mississippi flood control. After 1940 the Corps' work expanded into the area of military construction, including ammunition plants, Army posts, airfields, housing projects, and the great Pentagon Office Building in Washington, D.C.

As the Army's missile program evolved after World War II, the Corps of Engineers had been closely associated with it. Private contractors under Corps direction were responsible for constructing numerous facilities essential to guided missile research and training at White Sands and at Fort Bliss, Texas. During the 1950's and early 1960's the Corps had constructed installations for the emplacement of NIKE-AJAX and NIKE-HERCULES batteries across the United States. Not long after, Army engineers supervised the sinking of massive hardened underground concrete silos for TITAN and MINUTEMAN ICBM missile bases scattered across the Midwest.

The Corps of Engineers grew up with the Army's antiballistic missile program after March 1958. Its participation in BMD-related work steadily increased from a limited role in construction only for the basic ZEUS facilities at White Sands Missile Range to the development of criteria and final design, as well as construction, for the MAR-I and SPRINT launch facilities at the New Mexico range. When the Kwajalein Missile Range went into operation after 1959, the Corps of Engineers provided criteria development, facility design, and construction for the ZEUS installations there as well as for the later Meck Island prototype NIKE-X MSR building and its associated SPARTAN-SPRINT launching cells. Thus as President Johnson and his advisors debated the pros and cons of BMD during the summer of 1967, the Corps had already logged extensive missile facility experience in its record. Although none of the above listed facilities represented true prototypes of those required for SENTINEL, there was considerable similarity and much of the experience gained could be applied directly to the new system. On the other hand, the Army had never attempted to design and construct a missile program as large and sophisticated as SENTINEL in so short a time. This, it was thought, called for special measures.

As has been seen in the Prologue, on 2 December 1966 NIKE-X System Manager Lt. Gen. Austin W. Betts issued a Letter of Instruction that the Corps of Engineers should prepare itself to carry out the mission of designing and constructing NIKE-X tactical facilities if the order to go with his NIKE-X program should be given. General Betts' own NIKE-X Systems Command would continue research and development of the weapon system per se, i.e., the military hardware in the radars, missiles, and computers. In less than five months the Office of the Chief of Engineers responded with a detailed sixty-one page "Corps of Engineers NIKE-X Mobilization Plan," dated May 1967, which projected a unique NIKE-X Division, or CENXD, to execute any future

NIKE-X mission for the System Manager. This mobilization plan is especially meaningful to the history of the Huntsville Division, because under it the Division was conceived and actually born as the NIKE-X Division.[1]

Unlike existing Corps of Engineers divisions and districts, the NIKE-X Division-to-be was to have no geographical limitations on its operations; instead, it would be organized and operate in conformity with an exclusive national deployment mission that might take it into all fifty states. The May 1967 plan formally defined that mission as:

> To manage and provide technical control and direction of all aspects of the design and construction of Nike-X weapons system facilities and other Nike-X systems related construction. The CENXD function encompasses development of criteria, design and construction of R&D and tactical facilities, design and/or procurement of various types of Government furnished equipment, preparation of maintenance and logistics documentation, test and turnover of completed facilities and may include interim operation prior to turning over certain facilities to the using organization (ARADCOM).[2]

The Division's specialized mission also meant it would be under the command of the Chief of Engineers but operationally attached to the NIKE-X System Manager, or his deputy for technical matters, for programming and budgetary assistance in facilities acquisition. The details of command relationships and management procedures were to be worked out later in actual operations. According to the plan, formation of the NIKE-X Division was to take place in three phases: the first an indeterminate cadre period before "D," or deployment day; the second a Phase I permitting assembly and assumption of initial duties; the third a Phase II extending from assembly to the first construction contract award. Phase I would take about 180 days and Phase II no more than an additional 180 days to achieve full mobilization and independent operations; in the meanwhile the Division would be a foster child partially supported by other Army units as needed. The plan further envisioned that most of the Division's nucleus would come from the NIKE-X Cadre and Planning Group of four men already in being at OCE Headquarters under the Directorate of Military Construction, and from the NIKE-X Engineering Division, of the Mobile District. Others could be absorbed from the Advanced Technology Branch, Military Construction Division, OCE, a small group which had been exploring hardened electric power plants for NIKE-X. Peak authorized strength, excluding area offices, ultimately would be five military and 522 civilians under the command of a major general as division engineer.[3] This OCE plan swung into operation when the Department of the Army ordered SENTINEL deployment during the first weeks of October 1967.

The unit that would become the U.S. Army Corps of Engineers, Huntsville Division, was formally organized by authority of Department of the Army under OCE General Order No. 17 dated 9 October 1967. As of 15 October, there would come into existence the U.S. Army Corps of Engineers NIKE-X Division organized as a separate Class II activity under the command of the Chief of Engineers, to be headquartered at Huntsville, Alabama. Later the same day a modified General Order No. 17 from OCE corrected the earlier text to read U.S. Army Corps of Engineers, Huntsville Division (USAEDH)--the hectic haste that would characterize the Division's first months was already evident in its birth certificate.[4]

MAJOR GENERAL ROBERT P. (RIP) YOUNG
HUNTSVILLE DIVISION ENGINEER
OCTOBER 1967 - NOVEMBER 1970

Concurrently with the organization of the Huntsville Division, the NIKE-X Cadre and Planning Group, OCE, and the NIKE-X Engineering Division, Mobile District were transferred to it, but these personnel were to remain at OCE in Washington or at Mobile until activation. They did not have to wait long for their new jobs, because activation of the Huntsville Division was duly authorized on 15 October 1967 under Table of Distribution and Allowance No. CEW2V6AA00, which initially allocated it four Army officers and 136 civilian spaces. About one-fourth of these came on board immediately on a temporary duty basis from Washington or Mobile. Two days later, on 17 October, Brig. Gen. R.P. Young was named first Division Engineer. A graduate of West Point in 1942 and Harvard in 1948, General Young had served in North Africa and with the MANHATTAN Project during World War II. Prior to his Huntsville Division assignment, he had been Commander of U.S. Army Engineer Command, Europe. General Young's new division began to assemble in temporary quarters at 421 King Street, Alexandria, Virginia, while suitable office space was sought in Huntsville. The Division Headquarters stayed at King Street exactly two months.

While the Huntsville Division gathered at King Street during October and November, the larger Army infrastructure that it was to serve also began to take on an identity of its own. On 2 November the Department of the Army ordered that its DEMOD 1-67 ballistic missile defense system would thereafter be referred to as the SENTINEL System, and the next day the first ten site locations were announced. SENTINEL was now officially split off from the NIKE-X System, which continued a separate existence under General Betts to do advanced research in BMD. Timely progress in development and deployment of the SENTINEL System became the responsibility of SENTINEL System Manager Lt. Gen. Alfred D. Starbird, with the support of a SENTINEL System Office in Washington, D.C., immediately under the Chief of Staff, U.S. Army. General Starbird, then Director of the Defense Communications Agency, assumed his post on 15 November 1967. He would shepherd the SENTINEL System throughout its history and conduct its successor, SAFEGUARD, until April 1971. General Starbird's chief field organization was the SENTINEL System Command, or SENSCOM, with its headquarters in Huntsville, Alabama, conveniently near the missile talent and technology of Redstone Arsenal. The Commanding General of SENSCOM, Brig. Gen. Ivey O. Drewry, was also Deputy System Manager. SENSCOM's

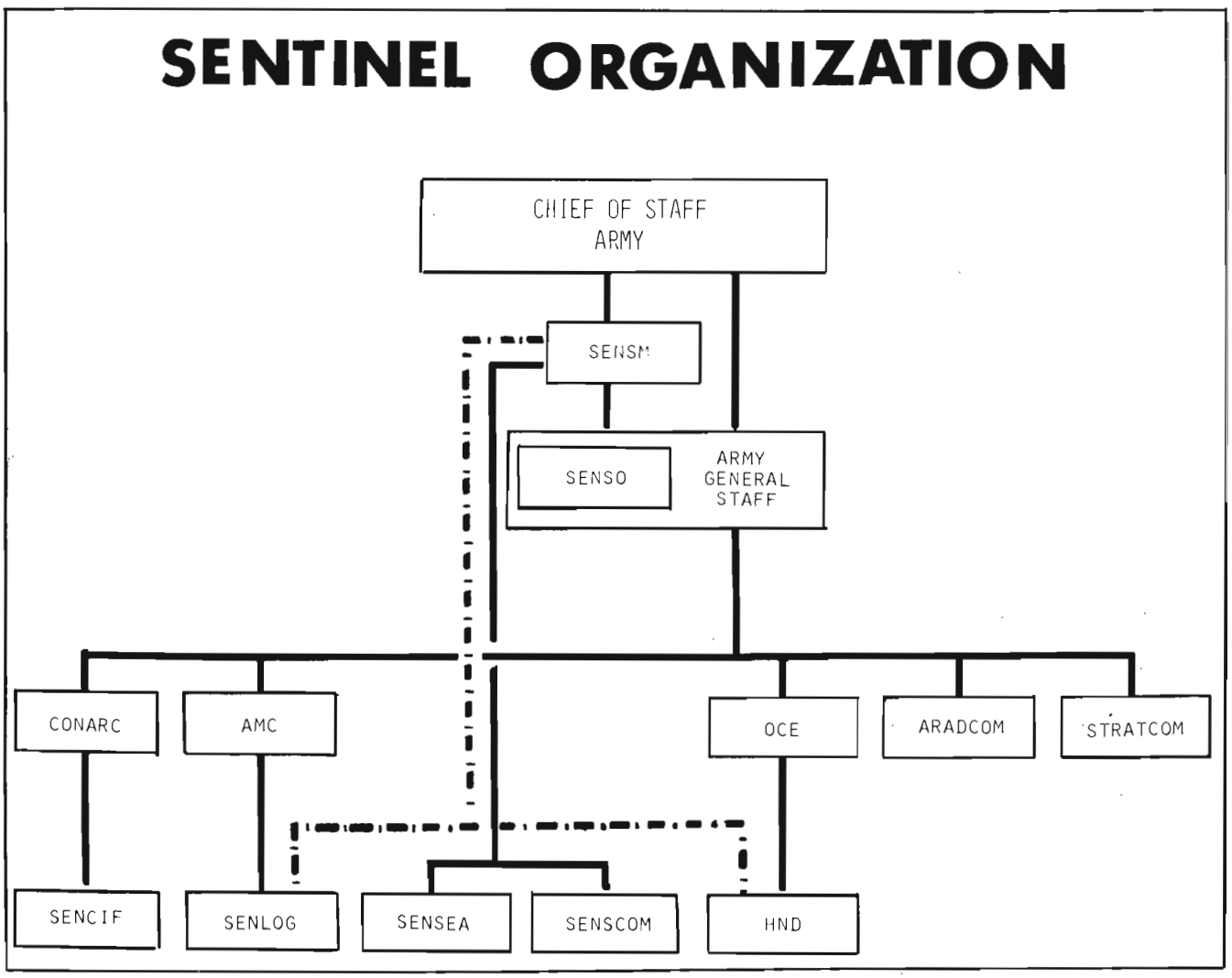
LIEUTENANT GENERAL ALFRED D. STARBIRD
SENTINEL SYSTEM MANAGER

mission was to bring the entire SENTINEL System to the point of operational readiness, whereupon it would be released to the Army Air Defense Command, or ARADCOM, the ultimate users of the System. In practice, SENSCOM's prime in-house concern was mostly with weapon system components, the radars, computers, softward programs, and missiles, while the Corps of Engineers prepared sites and built tactical support facilities to meet SENSCOM's requirements. In this mission General Starbird and SENSCOM were to get independent evaluation, review, and testing from the SENTINEL System Evaluation Agency headquartered at White Sands Missile Range, while logistical support would come from the SENTINEL Logistics Command. Other contributions would be taken from existing Army agencies and commands such as the Army Materiel Command, the Strategic Army Communications Command, the Continental Army Command, and the Army Air Defense Command. Training for the System would be conducted at the SENTINEL System Central Training Facility to be built at Fort Bliss, Texas.

It was understood from the beginning that Huntsville Division's special mission would necessitate both a singular internal organization and

some unusual external relations with OCE and with SENSCOM. Accordingly, soon after activation took place efforts were begun to draft to a formal statement of the Division's organization and functions. It quickly became apparent that the standard ER 10-1-3 regulation governing the assignment and structure for Engineer units could not be stretched to cover Huntsville's unique mission, and on 26 December 1967 OCE recommended that a special regulation for the Division be drafted similar to those for other atypical Corps formations. Huntsville Division concurred, and on 17 January 1968 it submitted a draft "Organization and Functions" proposal for consideration. OCE ultimately approved this proposal as ER 10-1-22, but only after the relationships between SENSCOM and Huntsville had been defined.[5]

A written Memorandum of Agreement defining the relations between the Corps of Engineers and the SENTINEL System Organization was not signed until 14 May 1968, or seven months after activation of the Division.[6] Essentially this statement simply formalized tentative assignments and working arrangements envisioned under the earlier "NIKE-X Mobilization Plan" and already put into everyday usage during the winter of 1967 and spring of 1968. The heart of the agreement was the understanding that Huntsville Division would be under the command of OCE but would provide service to SENSCOM under General Starbird's operational control. SENSCOM would supply general SENTINEL facilities configuration requirements to Huntsville Division, while the Division would furnish SENSCOM with the



three steps necessary in building all SENTINEL installations. In the earliest stage the Division would engage an architect-engineer firm(AE)to draft design criteria, a set of detailed parameters for one particular type of facility such as the PAR Building or MSR Power Plant. In a few cases, the Division assumed some criteria contracts already in existence as the legacy of NIKE-X. Having received, reviewed, and approved the design criteria, the Division would then negotiate for final design with a suitabie AE, usually but not necessarily the same firm that had prepared the criteria. The AE's final design had to implement all the Division's criteria in the form of minute plans and specifications, sometimes running to thousands of printed pages and design drawings. Finally, the Division would advertise, award, and manage a construction contract or contracts on a site-by-site basis. As usual with Corps procedures in such projects, the Division would supervise, guide, manage, and review work actually performed under contract with a variety of private firms.

Huntsville Division also agreed to work with Corps geographic divisions and districts in selecting, acquiring, and preparing the real estate for the SENTINEL sites located in their regions. Work schedules, layouts, and specifications for each site would be established by the Huntsville Division Engineer in coordination with SENSCOM to ensure that its requirements were met. In these activities, and in conducting public relations, the Division Engineer was expected to work hand-in-glove with SENSCOM's staff, and with General Starbird if necessary, to ensure that the interface between weapon system requirements and facilities compliance functioned smoothly. Formal control over both weapon system and facilities configuration always remained in the hands of the System Manager, who established milestones against which the program would be reported, including schedules, cost, and personnel. Funding for Huntsville Division's personnel and overhead came out of SENTINEL program funds included in the Corps of Engineers' budget, while the costs of real estate, design, and construction would be met out of SENTINEL funds administered by the System Manager. All SENTINEL real estate, design, and construction funds were authorized and appropriated by act of Congress in annual Military Construction Bills.

As Huntsville Division began to form as a unit in Alexandria, Virginia, after 15 October, a search went on in Huntsville for suitable office space. The hunt was not an easy one, because under the impact of the burgeoning space program and expansion of NASA at Marshall Space Flight Center, Huntsville was experiencing a boom akin to those of Old West mining towns. Office space was at a premium, and the Corps had to compete with private industry and with other Government agencies for the city's limited capacity. Nevertheless, a home for the new Division was eventually rented in the Huntsville Industrial Center Building, a three story former textile mill located in an older neighborhood at the corner of Meridian Street and Oakwood Avenue. Fortunately, the homely exterior of the building belied the interior, which some years before had been comfortably remodelled with carpets, paneling, and planters. The office on Huntsville Industrial Center premises opened for business at 0800 on Monday, 18 December, and sheltered joint Division-SENSCOM operations for the next year and a half while more modern quarters for both were built in Huntsville's new Cummings Research Park area. Early operations at the Division's temporary home were greatly facilitated by administrative and logistical help given by the U.S. Army Missile Command at Redstone, which supplied the Division with its first desks, typewriters, and file cabinets, and a generous supply of administrative assistance.

When the Division began its first workday in Huntsville on 18 December, fifty-six individuals reported for duty, and an additional thirty-two positions were committed. This strength represented just a little more than half of the Division's initial authorization of four officers and 136 civilians, and throughout the remainder of 1967 and the first months of 1968 active recruiting went on throughout the Corps of Engineers and other Governmental agencies to find qualified personnel. As in the case of office space, competition for talent was vigorous because of the simultaneous creation of SENSCOM and SENLOG, but the Corps' task and the Huntsville location were attractive, so there was no real dearth of applicants. By the end of December 1967 ninety-five positions, including four military, had been filled or accounted for, and by the end of January 1968 almost the entire initial personnel allowance of 140 job slots had been filled.

While recruiting for authorized spaces went on apace, the newly-arrived Dewey Rhodes, Chief of the Manpower Management Branch, and his assistants busied themselves planning the Division's future Table of Distribution and Allowances, refining the Division's organization, and considering the layout of a prototype area office. Their guidebook was the "NIKE-X Mobilization Plan," which furnished a

substantive model both for the Division's beginning organization and for its future growth. In mid-January 1968 the Division received a requirement from the SENTINEL System Office to make a comprehensive estimate of the Division's manpower needs for FY 1969 through FY 1977 with explanations for positions over and above end strength projected for the end of FY 1968. The resulting study indicated an immediate need for at least 230 civilians by the end of FY 1968 (30 June), and it predicted the Division would achieve a peak headquarters employment of seventeen officers, two enlisted men, and 525 civilians sometime in FY 1971. Peak levels for field offices would come with the crest of construction in July 1971, when thirty-six officers and 1,290 civilians would be on area office payrolls. The January study was approved, and the Division's explosive expansion during the spring continued when an additional ninety spaces were verbally authorized in mid-April, in part to permit immediate hiring of a large, highly skilled technical group then being released from Cape Canaveral District through a reduction-in-force. In fact, on 30 June 1968 the Division counted 263 (including eight military) on-board, with an additional eighteen civilian spaces committed.[7]

As Huntsville Division fleshed out during the winter and spring, its organization began to manifest two features unique within the Corps of Engineers, both of which could be directly traced to the Division's mission. Ordinarily the Corps' geographic divisions and districts maintained a military staff in their Executive Offices made up of a division engineer and one or two deputy and assistant engineers, but in the Huntsville Division this arrangement had to be elaborated to cope with the far-flung construction activities forecast for its future. As his chief assistants, Division Engineer General Young had Deputy Division Engineer Col. George A. Rebh, assigned to Huntsville on 27 November 1967, and no less than four assistant division engineers who joined in 1968. Among their responsibilities these four assistant division engineers acted as the Division's contracting officers, officially representing the U.S. Army in signing construction contracts. Construction in the Eastern Region of the United States fell under the supervision of Col. Robert W. McBride, the Central United States to Col. R.L. Kackley, Jr., and the Western Region of the country to Col. Lochlin W. Caffey. It was anticipated that one of these three contracting officers stationed centrally at Huntsville would supervise all SENTINEL construction sites located within his region. From Huntsville their liaison would spread down and outward to each of the half-dozen or so area engineers who headed on-the-job field offices at each site. Thus the chain of military responsibility for SENTINEL construction would run from the area office on-site to the assistant division engineer for the region in Huntsville to the division engineer and thence to OCE and SENSCOM. The fourth assistant division engineer, Col. Henry K. Mattern, was responsible for all the Division's vast procurement of standard hardware such as diesel engine generators, valves, electrical components, shock isolators, and chillers that the Government would purchase and furnish to contractors as Government Furnished Property (GFP).

Outside of the Executive Office the structure of the Division's technical staff also reflected Huntsville's singular mission. Other Corps divisions and districts maintained one engineering division to perform their engineering services, but from the beginning the "NIKE-X Mobilization Plan" had envisioned that the urgency, enormity, and complexity of the SENTINEL facilities design would demand not one engineering division but two within the NIKE-X Division. As the Division's mission took shape, this projection was fully vindicated. To satisfy Huntsville's large and sophisticated engineering workload, assignments were apportioned between a Systems Engineering and Development Division and a Facilities Engineering Division. Distinction between the pair's activities was often fuzzy, but Systems Engineering primarily worked closely with the weapon system contractors, so that as design progressed on radars, missiles, and computers, criteria development for their buildings and power plants could begin. Systems then researched alternative engineering solutions for specific criteria headaches such as the effects of shock and developed them to the point that final design could take over. Configuration management, standardization, systems effectiveness, reliability, availability and maintain-ability, value engineering, and programming also fell under the purview of Systems Engineering. This Division received its first chief on 5 May 1968 when John P. Coony joined by transfer from the Mediterranean Division in Livorno, Italy. Prior to his Mediterranean tour, Coony had participated in design of the enormous Saturn Vehicle Assembly Building for Launch Complex 39 at Cape Kennedy. Coony served throughout the SENTINEL program, leading a division responsible for many of the imaginative solutions found for the peculiar demands of hardened BMD installations.[8]

Next door to Systems Engineering the Facilities Engineering Division undertook project management for the final design of PAR and MSR buildings, their

power plants, remote missile sites, and for miscellaneous support facilities needed at each site. For the most part this meant the technical direction of contractors who were trying to meet frequently shifting directives handed down from BTL and other SENSCOM weapon system contractors. Facilities Engineering Division also handled engineering design duties such as survey, and site work, paving and drainage, architectural and structural, and utilities, and it provided engineer support services such as estimating, drafting and specification formulation. The first head of Facilities Engineering was Joe L. Harvey, formerly Chief Engineer of the Cape Canaveral District, who joined the Huntsville Division in December 1967. Like John Coony, Harvey was a seasoned military engineer whose career with the Corps of Engineers since World War II had included designing IRBM and ICBM launch facilities as well as installations for Mercury, Gemini, and Saturn space programs in Florida.[9]

Outside of the twin engineering divisions, the structure of Huntsville's technical staff was generally conventional. A Construction Division with Management, Inspection, and Reports Branches oversaw construction contracts let for each site. Bernard L. Trawicky was assigned as Construction Chief in December 1967. Trawicky's Corps career as a hardhat had begun in the European Theatre in World War II and continued in civilian life after 1946 as a permafrost construction researcher in Alaska. This background carried over when he became construction engineer at the great strategic air base at Thule, Greenland. Trawicky would remain at the head of the Construction Division throughout the SENTINEL and most of the SAFEGUARD period, transfer briefly to Chief of the Engineering Division, and retire in September 1975 after thirty-six years in Government service.[10] Huntsville's technical staff was rounded out by the Supply Division, whose first chief, Thor S. Anderson, came from the Defense General Supply Center in late 1967. As experienced as any of his colleagues, Anderson headed a division with responsibility for administering the myriad procurement and supply contracts buying millions of dollars' worth of crucial Government furnished items incorporated in SENTINEL facilities.

Inseparable from the establishment and shaking down of the Executive Office and technical staff was the setting up of housekeeping operations by the Division's administrative and advisory services. As in all parts of the Division, administrative staff personnel came from many backgrounds and parts of the country. To cite a few out of many situations, personnel for the Budget Branch initially were recruited from the Corps' Pacific Ocean Division, San Francisco District, Alaska District, and the Marshall Space Flight Center. William A. Campbell, the Division's first comptroller, joined on a temporary duty basis from the Ohio River Division to assist in the initial organization of the Huntsville Division at its temporary location in Alexandria, Virginia. He was permanently assigned to Huntsville Division in December 1967 following this TDY tour in Alexandria. The Internal Review Branch staff was obtained from the NASA Regional Audit Office and the Tulsa District, while the Management Analysis Branch cadre was derived from personnel recruited through the Memphis District and the North Atlantic Division.

Among the earliest support offices to take shape was the Office of Counsel which provided the Division with legal consultation on the fine points of contract law clauses. Again the Division enjoyed rich experience and high capacity in its General Counsel Emil Vuch, a quiet, gentlemanly lawyer who brought with him thirty-seven years of experience in Government legal service when joining the Huntsville Division in December 1967 from Canaveral District.[11] In addition to legal services, the Comptroller's Office, the Finance and Accounting Branch, Internal Review Branch, Budget Branch, and Management Analysis Branch also got off the ground during the early weeks of 1968, but some of these offices could not function on their own until mid-1968 because of the training, breaking-in, and orientation process.

The experience of the Finance and Accounting Branch was perhaps fairly typical of this maturation phase of early 1968. Personnel for this branch were obtained throughout the Corps: the Finance and Accounting Officer came from the Army Map Service, his assistant from the Baltimore District, and others from the Okinawa, Mobile, and Canaveral Districts, as well as from four of the Corps' civil works districts. The civil works group was not fully acquainted with military accounting procedures and was trained by accountants detached on TDY from the Mobile District. The Mobile District also tendered a lifeline by maintaining Huntsville's cost and finance records until 1 May 1968, when its own FCUSA Disbursing Station 5412 became operational. The first expenditures authorized by Huntsville's Finance and Accounting Office were made on 1 May, when $89.15 was paid out to Bowman's Rubber Stamp Co. of Huntsville for forty-five rubber stamps. Expenditures quickly became more substantial--the next day the Division

purchased $4,046.47 worth of adding machines, which allowed some of those borrowed from Missile Command six months before to be returned. By 1967 all Corps employees in the U.S. were being paid from a central payroll office in Omaha, Nebraska, so the Finance Office had no extensive payroll activity, but during the spring it still had to assure the prompt payment of Permanent Change of Station Claims for the 200-odd new-comers tranferring in. To assist with the heavy workload the services of four extra voucher examiners were obtained on a TDY basis from the Albuquerque, Buffalo, and Pittsburg Districts. During this same time the Budget Branch assisted in coordinating Mobile District support and the transfer of budgetary responsibilities to Huntsville. It also worked at laying ground rules for internal budgets and for the Division's operating program.

Even as Huntsville's first arrivals flowed in, set up housekeeping, and shook themselves down into a routine, attention in the engineering divisions was already focusing on the Division's first SENTINEL objectives, the selection of sites and the compilation of design criteria. Before detailing how the Division completed the initial phase of its mission, however, a word must be said about the general status of the SENTINEL program at its inception. Certain conditions of paramount importance prevailing in late 1967 remained throughout the ensuing months, combining to produce a dynamic and yet uncertain atmosphere for the Division's work which persisted until the suspension of SENTINEL in February 1969.

One of the most impressive characteristics woven into SENTINEL from the beginning was haste. From the deployment decision early in September 1967 to suspension of activity in February 1969, the entire infrastructure of the SENTINEL program labored under intense driving pressure dictated by tight scheduling. Having once established that a Sino-Soviet threat warranted building a BMD, the Administration and the Joint Chiefs of Staff apparently believed that its deployment should be rushed to the utmost. The exact scheduling of intermediate milestones planned for the program is still shrouded in secrecy, but two very important deadlines stand out--SENTINEL was to be designed, constructed, tested, and made operational fifty-four months after the deployment decision was taken.[12] In four and a half years, research and development had to be completed on all components and facilities, production undertaken, and seventeen sites constructed from unbroken ground that had been neither selected, investigated nor acquired. And since ground was to be broken on the first site at Boston, Massachusetts, by 24 September 1968, less than eighteen months were allocated for perfection of the weapon system, formulation of facilities criteria, final design for the first installations. Moreover, design decisions made during this period demanded a high degree of surety, because extensive standardization was planned for follow-on sites with the least possible variation amoung them. The large quantities of standard items to be procured--several dozen immense diesel engine generators among them--also demanded a lenghty lead time for supply, increasing pressure to award contracts as early as possible.

By itself, tight scheduling would have presented a sufficient challenge for the Division, but other factors intervened to further complicate the situation. The most bothersome complication was probably the development of the weapon system by SENSCOM in parallel with the early stages of building design. Apparently the original SENTINEL deployment decision had hinged upon the use of off-the-shelf NIKE-X radars, computers, and missiles to meet the fifty-four month deadline.[13] Unfortunately, the existence of such off-the-shelf NIKE-X units was a mirage since many of them were still undergoing development and some had not yet reached the prototype stage. The impact of this situation on Huntsville's work was direct, because there had to be a hand-in-glove integration of the weapon system with the building. Many aspects of facilities design hinged upon the confirmation of weapon system requirements and could not go forward until these were finalized. To cite just one example of many, the radar phase shifters and associated electronics generated enormous quantities of heat that had to be absorbed in the PAR and MSR Building's cooling systems. Design of these cooling systems, however, could not proceed with certainty until the requisite type and capacity of cooling was established by the weapon system contractor. As late as 6 June 1968 General Electric Co. was still uncertain as to whether it would use air or water cooling for its PAR phase shifters, and a final decision as to the quantity of cooling air needed was not reached until the fall.

Adjustments in facilities design could be accommodated fairly easily for the data processing equipment and the missiles, but the lack of definitive specifications was particularly embarrassing in the area of the radars, where an especially intimate interface had to be maintained between electronics and building. This situation was most notable in the case of the PAR Building, because no prototype of either the radar or its building existed. It was intended that the first PAR scheduled for Boston,

Massachusetts, would do double duty as a prototype and production-type installation, drawing on extensive prior experience with the MAR-I type radar at White Sands. Confidence in the configuration of the MSR could be much greater because a semi-soft prototype with two antenna faces was nearing completion on Meck Island in the first months of 1968. The natural consequence of this fluid situation was that changes in building requirements were numerous and continued to be handed down well into 1968, persisting even after the initial production contract for $85 million worth of SENTINEL radars was awarded to prime contractor Western Electric on 1 April 1968.

Essentially, then, at the inception of the SENTINEL program, the contractors had to translate mostly proven technology into a weapon system whose existing components were still unfinished and had never been assembled as a whole. But not all changes could be laid at the door of BTL, WECo., McDonnell-Douglas, Martin-Marietta, General Electric, and other purveyors of hardware. There is evidence that Department of the Army issued significant changes in the configuration of certain SENTINEL installations sometime during 1968. The exact nature of these modifications is still secret in 1977, but it is highly probable that the original intention to build all PAR's with a single face was being changed to a plan to build some PAR's with an additional seaward face to deal with Soviet submarine-launched missiles. One of these two-faced PAR's was to be installed at Boston, a fact which further pressed for a quick design solution.[14] Responsibility for this state of affairs lay outside Huntsville Division and beyond its control, but the Division's engineers soon learned to expect constantly shifting SENSCOM needs and to meet them without unduly compromising deadlines or incurring excessive cost penalties.

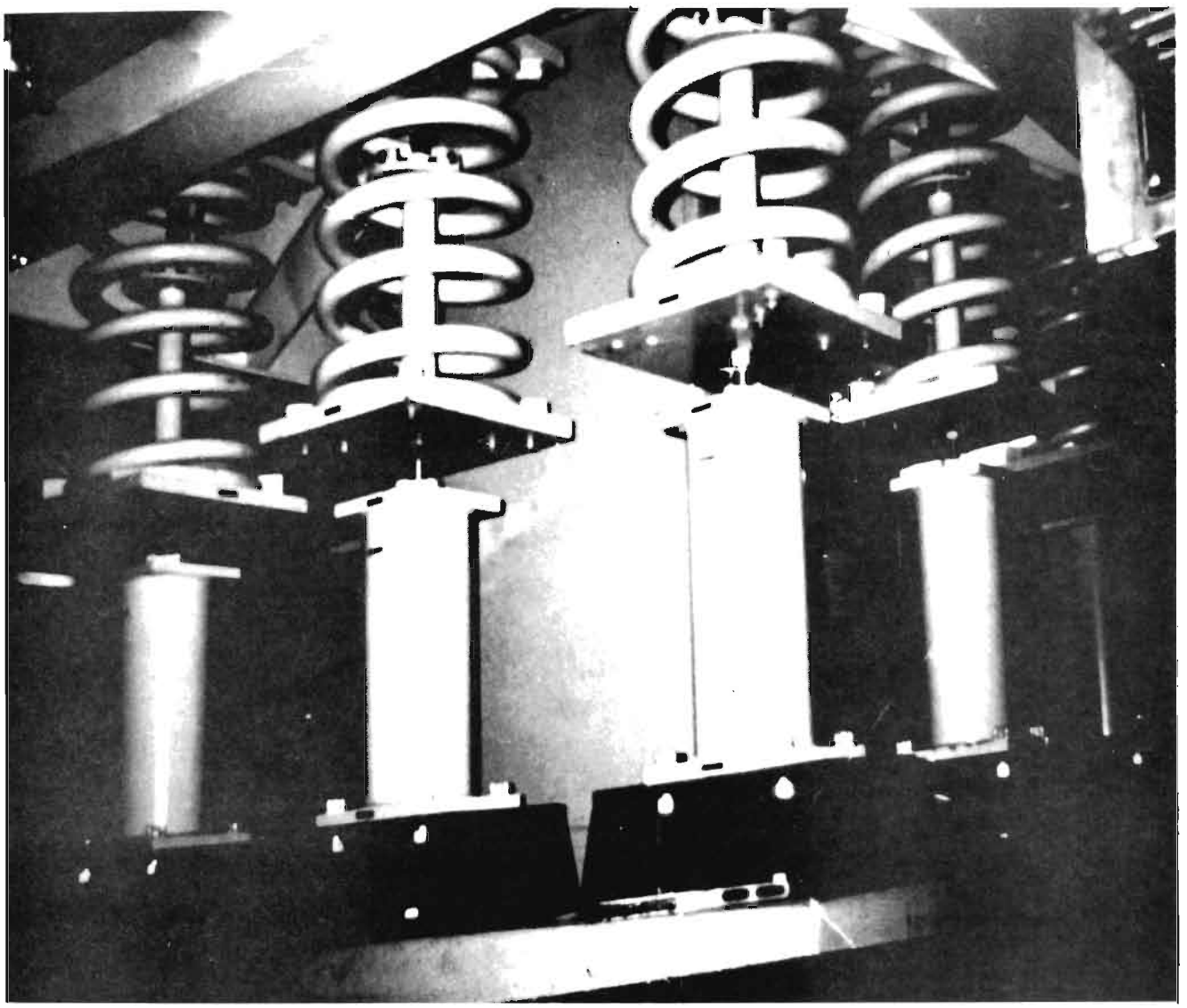
In the first major phase of its mission for SENSCOM, the Huntsville Division was asked to develop all the necessary criteria to "harden" the SENTINEL radar buildings, their power plants, and the SPARTAN-SPRINT missile launching stations. In military engineering parlance,"hardening" means protection from the immediate and after effects of nuclear explosions near the facilities--the precise number and size of the explosions and the "circular error of probability" or distance from the blast over which protection extended constituted the requisite amount or degree of hardening. Another factor was the length of time that buildings had to remain self-sufficient, or "buttoned-up" after combat ensued. In the case of SENTINEL facilities, the degree of hardening has remained secret, as has the "buttoned-up" period, but despite this a general picture of the engineering problems and some of their solutions can be offered here. The degree to which these solutions would have proven successful under the conditions projected for them, of course, continues to be debated, but the controversy has no part in this history. In all cases the Division solutions met or exceeded the requirements laid down by SENSCOM and SENSO and did so with a high degree of reliability and cost effectiveness.

The necessary criteria for SENTINEL buildings might be broken down into the overriding ones prevailing under attack conditions and some less dramatic ones prevailing during round-the-clock, day-in and day-out operations of peace-time. Reduced to their essentials, the hardening criteria demanded the creation of partially buried, multistory structures that would permit the delicate radar apparatus and its three-shift crews to survive nearby nuclear explosions and go on operating on a self-sufficient basis during the hostile aftermath of the explosions, probably for a period of several days thereafter. No hardening was planned for support facilities such as barracks, commissaries, chapels, classrooms, recreation facilities, headquarters buildings, and the like. These were considered expendable and were designed with straightforward methods and materials.[15]

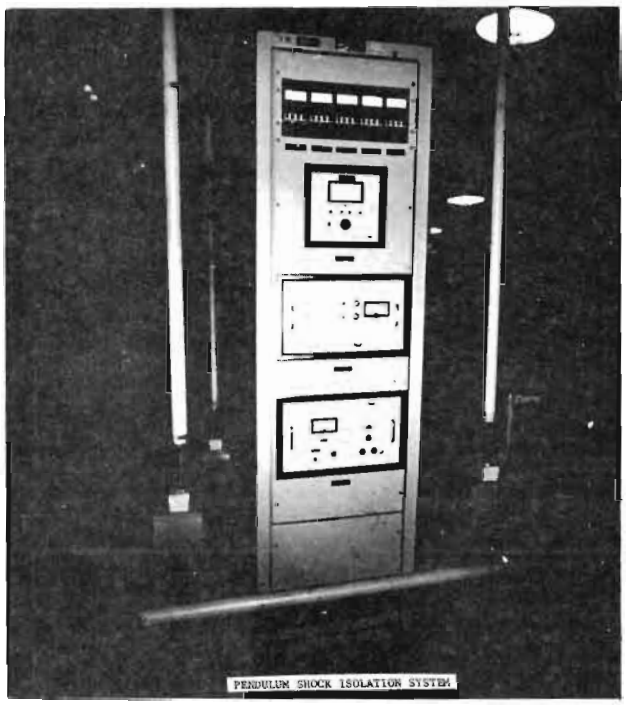
During and immediately after a nuclear blast, SENTINEL buildings would be hit with a powerful blast of heat and light, followed by a tremendous shock wave through the air and ground. The air pressure of the blast was usually called overpressure and was measured in pounds per square inch of surface area. Though the exact figure remains secret, private sources indicate that SENTINEL buildings likely had to withstand about twenty-five p.s.i. of overpressure, or about two and a half times normal atmospheric pressure.[16] The ground shock wave could cause the earth to heave several inches for a few moments as if it were a plastic medium. This would in turn transmit severe shocks throughout nearby buildings, electronic equipment, piping, wiring, and power generating machinery. Countermeasures adopted for building shells generally followed conventional construction practices: concrete walls and floors of great thickness were strengthened by liberal use of large reinforcing steel rods throughout. Windows, of course, were totally ruled out and other openings minimized, most access being through a buried concrete tunnel leading to the power plant and thence to the outside.

It was predictable that some special problems would be forthcoming as a result of shock effects on the internal environment of the buildings. Until March of

1968 limited research and development studies in the area of shock isolation led both BTL and the Corps to believe that shock isolation would not be a significant problem. However, by March new studies using sophisticated computer programs indicated that shock loading would be higher than previously thought and would require either "ruggedization" or shock isolation of certain sensitive tactical support equipment. Two possibilities emerged: either more durable equipment could be designed, developed, and procured, or readily available ordinary commercial components could be protected through careful shock isolation procedures. Early cost trade-off studies indicated a clear advantage for using protected comercial equipment, and this became a vital design requirement, especially for the radar buildings which housed delicate electronic components and systems. In late October of 1968 design AE's were instructed to include shock isolation in their designs, and in November 1969 a contract was awarded to Wyle Laboratories for shock isolation testing of sensitive mechanical and electrical equipment.[17]

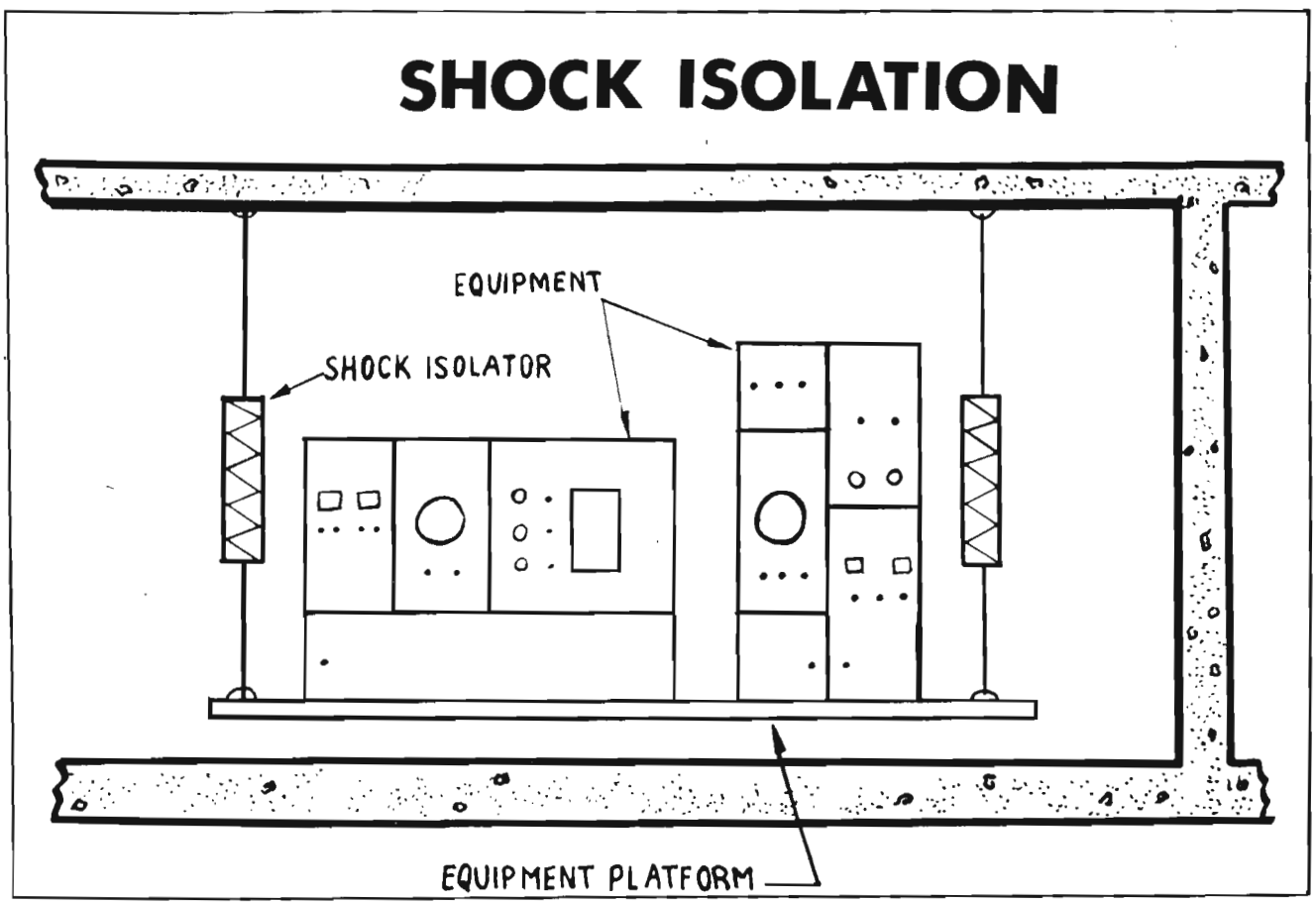


BASE MOUNTED HELICAL SPRING SHOCK ISOLATION SYSTEM



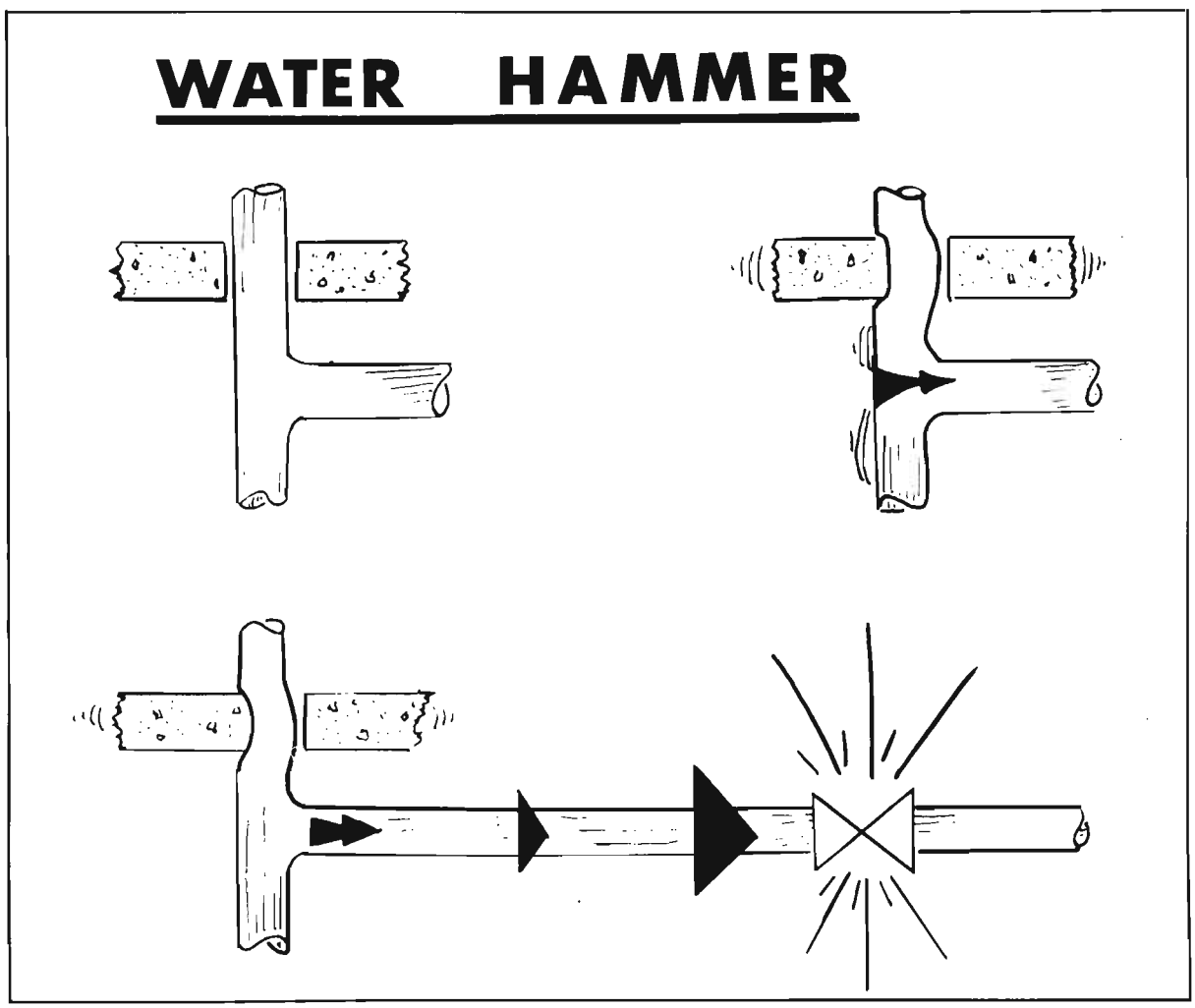
PENDULUM SHOCK ISOLATION SYSTEM

Wyle's testing considered the three dimension nature of the problem, the movement displacements involved, the flexibility of supported loads, accessibility, damping, and other considerations. Interestingly enough, the eventual solution produced was astoundingly simple in theory: both helical coil springs similar to those on automobiles and air spings were used in both pendulum and underfloor mounting positions. Air springs were used for spring loads greater than 2,000 pounds; coil springs were used below this load level. Eventually over 300 platforms were shock isolated, ranging in size from very small panel platforms two feet square requiring only two isolators to very large platforms of 3,000 square feet that required sixty isolators. More than 1,200 kinds of isolators were used with static load capacities ranging from 128 pounds to 40,000 pounds. The largest supported load was 260,000 pounds, or 130 tons.[18]



A second effect of the severe shock environment was the introduction of a pulse through fluids in piping. This created a transient condition of high hydaulic pressures in water, sewerage, and fuel lines--in layman's language, a kind of water hammer surge--that could burst line or jam valves, causing breakdown of equipment and the possibility of oil-fed fires. After recognition of what a shock-induced surge could do, in September of 1968 Illinois Institute of Technology's Research Institute was contracted to study the problem and recommend solutions. Ultimately it was demonstrated that surge attenuators placed in piping would alleviate the hydraulic effect and that flexible connections between rigid lines and shock-mounted equipment would absorb relative movements experienced during the blast period.[19]

Accompanying the immediate blast effects of heat, overpressure, and shock were certain other phenomena peculiar to nuclear explosions, including gamma and neutron radiation and a burst of electromagnetic radiation known as the Nuclear Electromagnetic Pulse, or NEMP. At the inception of SENTINEL, the effects of various kinds of atomic particle radiation were fairly well understood from prior nuclear testing, and it was known that thick concrete walls and similar shielding features could deal with them. NEMP, however, was quite another matter. In effect it can be best described as a broad band electromagnetic radiation causing disruption of unshielded electronic units similar to radio noise interference but of greater intensity. The NEMP effect could penetrate concrete walls, thus requiring

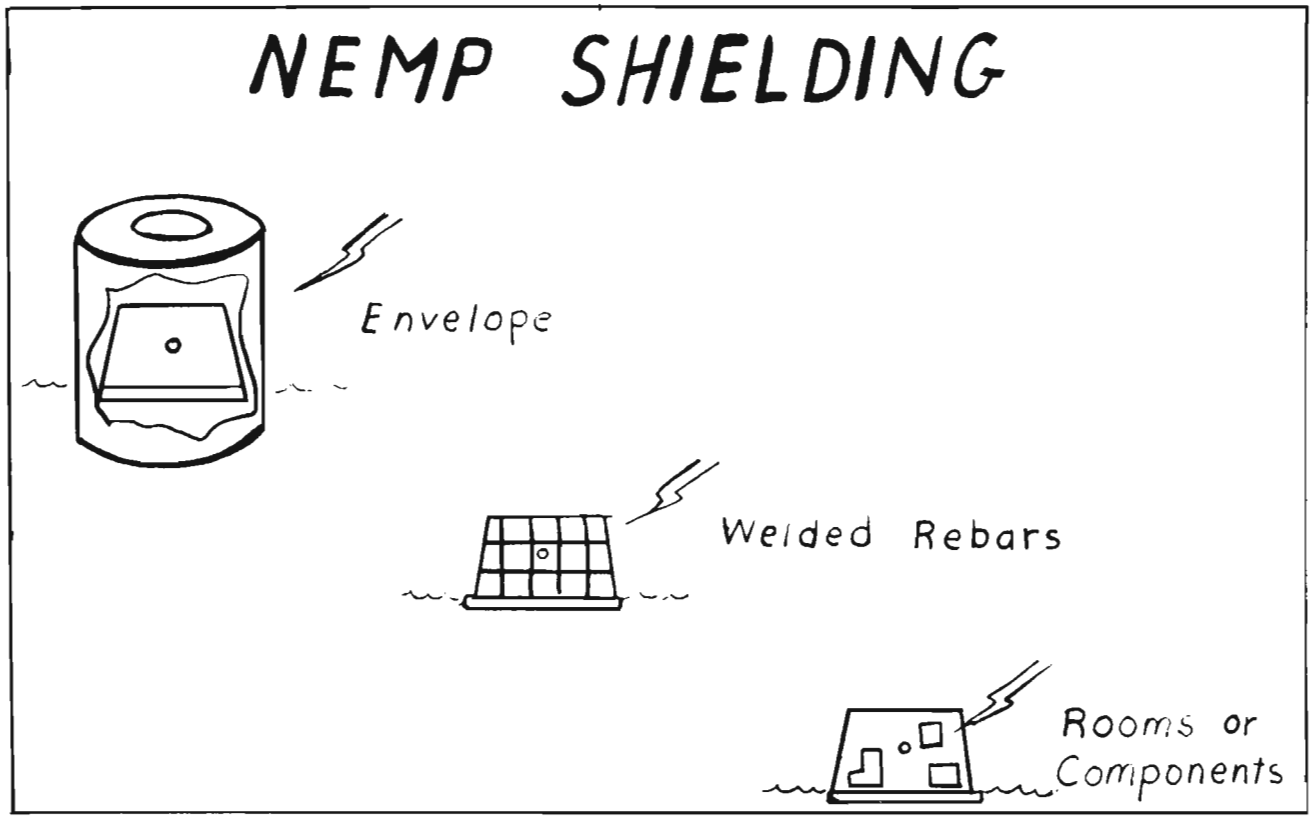


extensive metallic shielding against both the electric and magnetic components of the electromagnetic field. It required much study and effort to understand and cope with this phenomenon on the scale of SENTINEL buildings and their electronic contents because the NEMP could seek out the smallest gap, connection, fault, or break in an electrical ground so as to wreak havoc with components and circuits. Design decisions had to take into account the size and distance of explosions, the type of equipment being protected, the integration of shielding with the remainder of the structure, and the cost of potential solutions. Additionally, it was especially difficult to research the problem in the field because atmospheric nuclear testing had been suspended since the early 1960's, and underground testing did not yield wholly conclusive answers.

Study of the NEMP phenomenon at Huntsville began when the Division assumed a contract let in 1965 to General Electric Co., Pittsfield, Massachusetts, by OCE for "Development of NEMP Protection Evaluation." But no plain answers were yet in hand by 1967. NEMP requirements remained unsettled throughout the early sping of 1968, and on 21 March the SENTINEL NEMP Studies Committee decided that a wholly conservative approach calling for total external shielding of radar, power plants, and interconnecting tunnels had to be taken. It was estimated at the time that this would cost about $3 million per site, and this additional cost perhaps helped delay final approval of any shielding scheme for as long as possible. In May 1968 it was decided to use welded reinforcing bar loops in the walls of the less sensitive power plants, with further study to be given the thornier problem of the radar buildings. A final decision on NEMP remained in abeyance throughout the summer of 1968, though the matter was extensively discussed at the Vulnerability Task Force meeting of the Defense Sciences Board at Redstone Arsenal on 21-22 August. At the meeting BTL made a presentation concerning NEMP protection for its system, but General Starbird requested that a detailed discussion be deferred until a full position could be developed. The old bugbear of how much cost for how much protection was evidently still at work. The issue of NEMP protection for the radar buildings was finally resolved on 23 October, when General Starbird decided that the shielding at Boston and following sites must incorporate the totally shielded principle for radar facilities and limited critical area shielding for the less sensitive power plants. Huntsville Division was to choose the most effective and economical application of this principle.

The method to be used for the radars was determined as a result of feasibility and cost studies carried out by The Ralph M. Parsons Co. and Amman & Whitney, the AE firms designing the MSR and PAR Buildings. One month later, on 22 November, Parsons and Ammann & Whitney reports indicated that different approaches for the MSR and PAR Buildings would be most appropriate. In the case of the simple cubical PAR Building, Ammann & Whitney developed a structural design providing an uninterrupted internal envelope shield made of 11 gauge steel plate completely lining the ceiling, four walls, and first floor of the twelve-story high building. In effect, the PAR Building was totally canned on the inside. The toughest part of the design was maintaining continuity of the shield at the floor-wall intersections without impairing the structural integrity of the building. Every butt joint and each penetration the liner for reinforcing bars, piping, wiring, conduits, ducts, bolts, or punctures of any type had to be carefully welded and then magnaflux tested to insure the electical continuity of the joint. The magnitude of the problem was staggering when one considers the thousands of such joints, each of which had to be done to perfection.[21]

The same degree of perfection had to be maintained in the MSR Building which was much more complex geometrically. Considering its unusual triangular turret walls, oblique intersections, and huge antenna openings, the Parsons solution opted for a room-by-room approach. Only the areas containing sensitive electronics equipment were continously shielded in much the same way as the Ammann & Whitney design for the PAR. [22]



Inextricably associated with immediate nuclear effects were an immense variety of other exotic engineering challenges that resulted from the hardening requirement. Just a few of these can be mentioned here, but among other things Huntsville Division had to devise a means to pass the PAR's phased-array antenna elements through a concrete face wall ten feet thick (the "A" or antenna face wall), then pass the bundles of collected element group power feed cables through the "A" wall-floor intersection without weakening it while still maintaining integrity of the NEMP liner plate. Inside both the MSR and PAR Buildings, solutions had to be found for engineering a habitable environment for electronic parts and crew alike. This was a formidable undertaking indeed, embracing such diverse factors as fire protection within a sealed building, separation of male and female quarters, climate control, utilities, and psychological stress resulting from closed quarters.

Lest the sophistication of these demands be underestimated, the reader should consider for a moment the superficially simple problem of fire control within a "buttoned-up" building. There were two possible solutions, and each had its limitations. Chemical firefighting was especially suitable for the kinds of electrical and oil fires expected, but the use of chemicals in the closed buildings might have generated dangerous toxic fumes worse than the fire hazard. A more palatable but less effective alternative was the utilization of water and a drain system--but where was one to drain off the water once it was sprayed on a fire? And what would be the consequences of water in electrical gear? Eventually it was decided that the latter scheme offered fewer risks than the former, and it was adopted.[23]

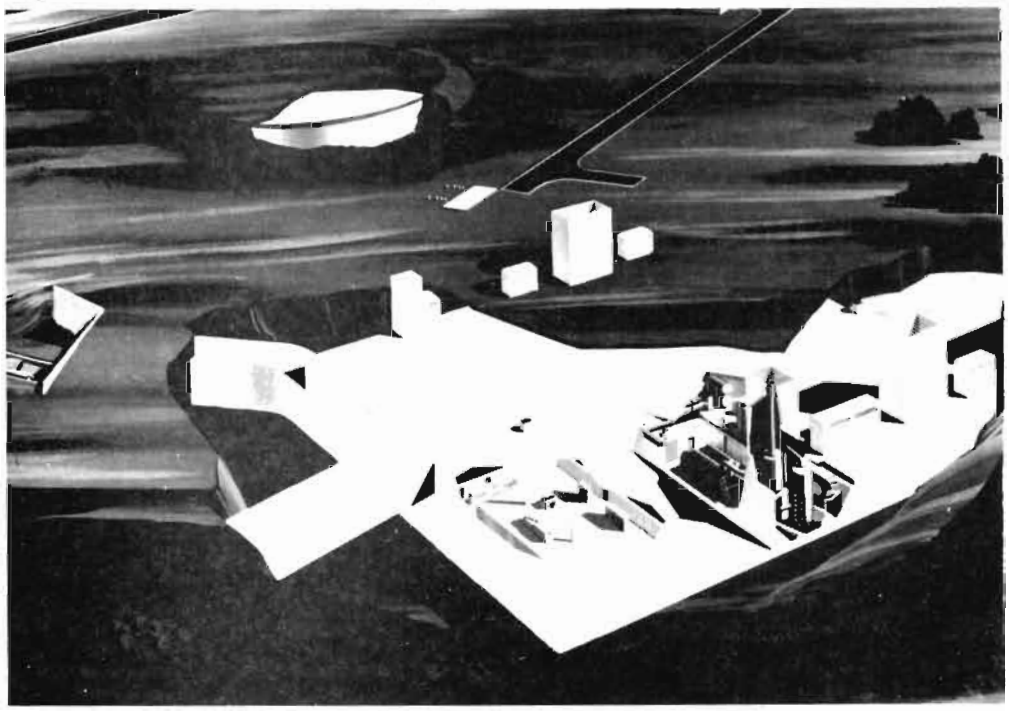
Not the least problem in facilities criteria was to provide a suitable power plant for the MSR and PAR Buildings which could generate enough electricity for a city of 40,000 and go on doing so for several days after a nuclear strike. This involved shifting from external commercial ties to internal emergency power automatically, then supplying facility generators with fuel, filtered air, and cooling water through sealed self-sufficient systems that would be fail-safe in the "buttoned-up" mode. Large fuel storage tanks had to be made rupture-proof, intake air cleansed of choking dust, and a recirculating water system devised to incorporate vast underground heat sinks for cooling. Early OCE studies during 1964-1967 had weighed the merits of both turbine and diesel engine generating equipment, but the excessive fuel consumption of turbines discounted their employment in favor of multiple diesel units. Blast resistance dictated that the

whole plant be buried underground, except for the exhaust and intake stacks; other parameters mandated that the plant adjoin its radar and be accessible to it through a large hardened tunnel. These factors in turn provoked other considerations, such as a shear-proof joint between the tunnel and radar building that would also be NEMP-protected.

Finally, in addition to the signally stringent engineering criteria set out for wartime operation, there were numerous other lesser requirements for normal operation stemming from climate, local electromagnetic conditions, accessibility for maintenance, and other factors. The potential effects of freezing and snowfall on facilities had to be investigated; so too did the indigenous interference from local radio, television, and microwave transmissions. Even mundane problems sometimes grew to significant proportions: limited interior space handicapped movement and replacement of large components, while maintenance outside had to take into account the arc swept by powerful radar emission that could prove dangerous to human and animal intruders wandering in front of the antenna faces.

The development of criteria for some of the types of facilities needed for the SENTINEL program had actually gotten underway as part of the NIKE-X program during 1965 and 1966. As noted above, when Huntsville Division was activated in October 1967, a small group of engineers in the Advanced Technology Branch of the Military Construction Division at OCE in Washington, D.C., was already at work on hardened electric power plants for NIKE-X. At Mobile District, about thirty men in the NIKE-X Engineering Division was busy researching other aspects of design criteria for NIKE-X buildings, producing among other things the layout for the prototype MSR located on Meck Island in the Pacific. These pre-SENTINEL activities resulted in a broad foundation whose value was greatly increased by the expertise that transferred with OCE and Mobile personnel in 1967.

The prior accomplishments at OCE and Mobile District were particularly evident in the time that was saved in designing the MSR and MSR Power Plant. On 1 September 1966 the Mobile District had awarded a contract to the AE firm of The Ralph M. Parsons Co. of Los Angeles, California, for the development of design criteria for the MSR Building.[24] The criteria arrived at under this contract were being finalized just as the Huntsville Division came into existence in October 1967, and during the next few months the new division assumed management of this contract. In a like manner, Huntsville Division also inherited all of the very considerable knowledge that had been gained about hardened electric power plants through several dozen contracts dating to the beginning of the NIKE-X era. A large part of this fund of prior knowledge was directly applicable to the MSR Power Plant.[25]



BMD POWER PLANT CUTAWAY. Underground entrance on left, heat sink at upper left, cooling towers upper right, and intake and exhaust stackes in center of rendering.

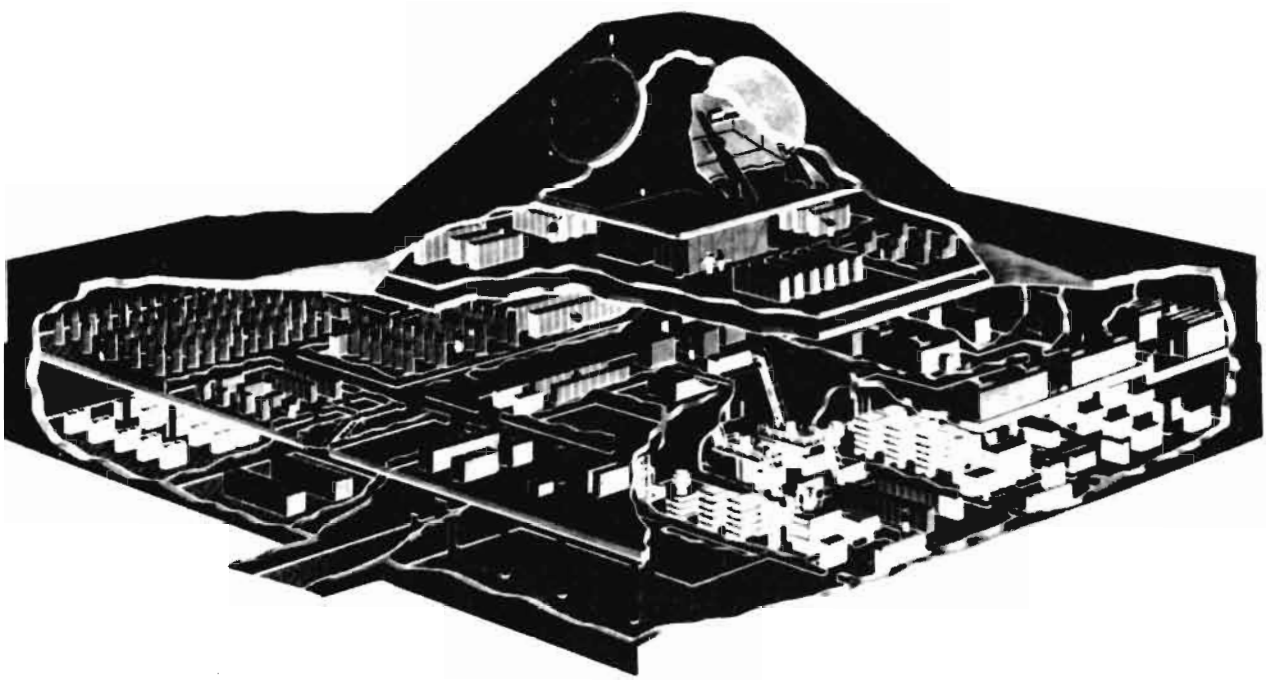
The advanced state of work on the MSR and its power plant permitted final design of these to be started early in 1968, even before the Huntsville Division was staffed to handle the necessary contracts. On 29 January 1968, the Mobile District awarded contract DACA87-68-C-0001 for $4,904,174 to The Ralph M. Parsons Co. for final design of the MSR Building based on criteria previously drafted by them.[26] This contract was one of four necessary to complete the design of major SENTINEL facilities, and although technically awarded by Mobile District, it was a land mark in the history of Huntsville Division, since Huntsville promptly took over its management. The contract for the MSR was quickly followed by a similar one for design of the MSR Power Plant. On 12 February 1968, Bechtel Corporation of Vernon, California, was engaged to submit a final design proposal for electric power installations associated with the MSR. The cost-plus-fixed-fee contract amounted to $1,627,469.[27]

The Parsons MSR Building design bore a close resemblance to the prototype then being finished on Meck Island and was almost identical with the Missile Site Control Building (MSCB) later deployed in SAFEGUARD. The MSR Building comprised a massive reinforced concrete structure having 127,000 square feet of usable floor space distributed among four levels. In form, the building could easily be pictured in the mind's eye as a combination of two simple geometric solids. Visible above ground was a four sided truncated pyramid, each of whose four faces was set with a round radar "eye" flush with its surface (some MSR's were to have fewer antennas). The seventy-nine foot pyramid turret rested on a larger two level square structure 231 feet on each side completely buried underground. Because the turret's sloped walls offered less vulnerability and the subterranean construction more protection, the MSR Building could be more lightly constructed than the above ground PAR: the exterior walls were three feet thick and the interior walls one and one-half feet thick.

The most interesting engineering features and problems of the building lay in the turret design and construction. Each of the four turret faces held a thirty foot diameter MSR antenna mounted integrally with the turret wall; that is to say, there was no concrete directly behind the area of the antenna face. This meant that the antenna had to be strongly made and well secured to the surrounding concrete to offer sufficient hardening. In fact, each MSR antenna weighed over 400,000 pounds, or 200 tons, a weight which had to be emplaced and held in a round opening in the turret face. The eventual engineering solution was to support the antenna in an antenna adapter ring consisting of a thirty foot inner diameter steel ring divided into thirty-six shear keys equally spaced around its perimeter. The steel ring contributed nothing to the strength or stiffness of the opening, for each shear key acted independently to deliver its load directly to the adjoining concrete. In the rear, the antenna and antenna adapter ring were supported on massive towers and a radial framework resting on the fourth floor slab. Together the ring and support system made up a tremendous weight and necessitated a major engineering effort to ensure that the permanent structure was not over-stressed.

The equipment that made the MSR Building a tactical nerve center in the overall BMD scheme was housed in the two lower levels beneath the turret. Here were located the radar transmitting and receiving components, phase shifters, switching gear, and many of the systems necessary to keep the building operating and habitable under all conditions. Here too was located the data processing equipment that in milliseconds received crude signals from the radar antenna (and in some cases, a distant PAR), digested it into machine language, discriminated among incoming objects, computed intercept trajectories, and finally guided the intercept with SPARTAN's and SPRINT's. The sensitive electronics of this area were protected against NEMP room-by-room on an as-needed basis by the continuous 11 gauge liner plate shielding described previously.

The power plant for the MSR was housed nearby in a partly buried hardened concrete structure mounded over with earth at the surface for blast protection. Inside the plant, six sixteen-cylinder diesel engine generators with a capacity of 17.3 megawatts could supply precisely regulated power for use under alert-attack and post-attack modes, but peacetime power requirements were to be met from commercial sources with some of the generators idling in one of three lesser stand-by modes. Provision for emergency operation was complete with interconnected hardened fuel oil supply sufficient for several days and a sealed recirculating water cooling system featuring a vast underground storage cavern as a heat sink. The power plant was connected with the MSR through a concrete two story tunnel fifty feet long. Utility lines, control cables, hoses, and the like were routed through the upper story, while through the lower level ran an ingress and egress passage for personnel and equipment. Tunnel and MSR were joined by a flexible junction that maintained NEMP protection throughout.[28]



CUTAWAY OF A MISSILE SITE CONTROL BUILDING (MSCB)

Through no fault of the Corps of Engineers, the initiation of final design for the PAR Building and PAR Power Plant proved to be far more lengthy and trouble-ridden than for the MSR facilities. Because no exact prototype of either the radar equipment or the building existed when SENTINEL began, BTL, the radar prime contractor, found many adjustments necessary in the configuration of its product as it was prepared during 1968. For example, in January 1968 BTL was undecided about radar power levels, about air or water cooling for phase shifters, about whether it would use a horizontal or vertical transmitter layout. Just as in the MSR, there was a close tie between weapon system and building, with changes in the former often directly influencing changes in the latter. To absorb some slippage on the part of the weapon system contractor, Huntsville Division often agreed to squeeze its tight schedule still further. A typical instance of this is dryly recorded in the "Historical Summary" entry for 15 March:

> SENSCOM stated a need to reduce scheduled construction period for the Boston PAR by as much as 6 months to provide the WSC [Weapon System Contractor] additional time to install, test, and evaluate the first generation PAR system. This site is essentially an R & D installation. A CPM [scheduling] evaluation of the latest PAR concept indicated 25 1/2 months for a normal construction schedule. SENSCOM was advised that, by doing excavation and foundations during the summer and fall of 1968, and by the use of multiple shifts, the new BOD [Beneficial Occupancy Date] could be met at a 35 percent or $10.4 million increase in cost.[29]

Scheduling and rising costs got thorough scrutiny during the first weeks of April, but it was still found that a normal schedule, already very tight, had to be accelerated by at least five months. To these pressures and ambiguities were added other, still classified, modifications apparently originating at Department of the Army level that were concerned with designing a single face PAR that could be expanded into two faces, or possibly with one and two face buildings that used common features. The net result of these factors

taken together was that launching the final design for the PAR facilities lagged by at least six months behind the MSR facilities.[30]

The development of the PAR building by Huntsville can be said to have actively begun with the award of an engineering contract to the AE firm of Ammann & Whitney by Mobile District on 7 December 1967. Working closely with BTL, Ammann & Whitney proceeded to prepare several short-term analyses for buildings with radars of various power levels. On 9 February 1968, BTL decided that it would utilize a single combination transmitter-receiver antenna array in the PAR, and shortly thereafter it opted for the horizontal layout of transmitter elements. By 15 May, Ammann & Whitney had produced a report offering three major building choice varying in the amount of floor space and location of the power plant under the building or to one side. At this time, floor space was estimated at 210,000 square feet, but it was hoped that this could be significantly reduced to save money.

Some decisions on these configuration matters and others at the end of May and early June paved the way for award of a final design contract. After briefings and reviews by SENSCOM Commanding General Drewry and SENSM General Starbird, and AE contract in the amount of $3,216,209 was awarded to Ammann & Whitney on 14 June for final design of the PAR Buildings to be located at Boston, Massachusetts, and at Detroit, Michigan.[31] Design of the power plant for the PAR encountered fewer vicissitudes than the main building, and a $939,594.93 design contract was awarded on 28 June to Black & Veatch Co. of Kansas City, Missouri.[32]

Even after award of final design contracts, however, the configuration of the PAR Building and its power plant was continuously re-evaluated in the light of new information. On 21 June, General Starbird approved design of the PAR Building based on a 167,000 square foot building, but he also directed that study of alternatives be continued with the hope of cost savings. About this time, it was found that the building would probably have some excess space, at least until another radar face was added, and changes were inaugurated to move some of the soft administrative and support structures such as the headquarters building and classified classrooms into the PAR Building. On 13 September, another major reconfiguration made by the System Manager was estimated to delay design completion by about two to three months and cause changes in foundation design for the first phase construction contract that was already being advertised for Boston.

On 24 September 1968, Phase I construction excavation for the first PAR began at Boston, but on 11 October another configuration revision required a change in the construction contract to increase the size of the foundation excavation. In this instance, the power plant was moved twenty-feet closer to the PAR and lowered ten feet. This was more economical construction-wise but called for more rock excavation. On the same day, 11 October, design of the PAR was finally frozen--but when on 7 November BTL again offered some savings in floor space, Ammann & Whitney agreed to accept the change without slipping the 1 April 1969 completion deadline for final design.

The 1968 Ammann & Whitney design for the two face Boston PAR was distinctly odd, featuring an irregular polygonal wing jutting out one side of an otherwise cubical building. Of the design, the Division's historian later wrote:

> Unfortunately, the required geometry of the building did not lend itself to presenting a nicely proportioned structure of rectangular shapes. However, until models of the building were constructed, no one had visualized its unusual appearance and some people tended to object. A number of different ways have been reviewed to improve the geometry of the building without incurring major design, unacceptable delay, or increased costs. This effort was not successful. The PARB is not necessarily an ugly building, and, in this era of modern art and architecture, it will not be an isolated example of unusual building form.[33]

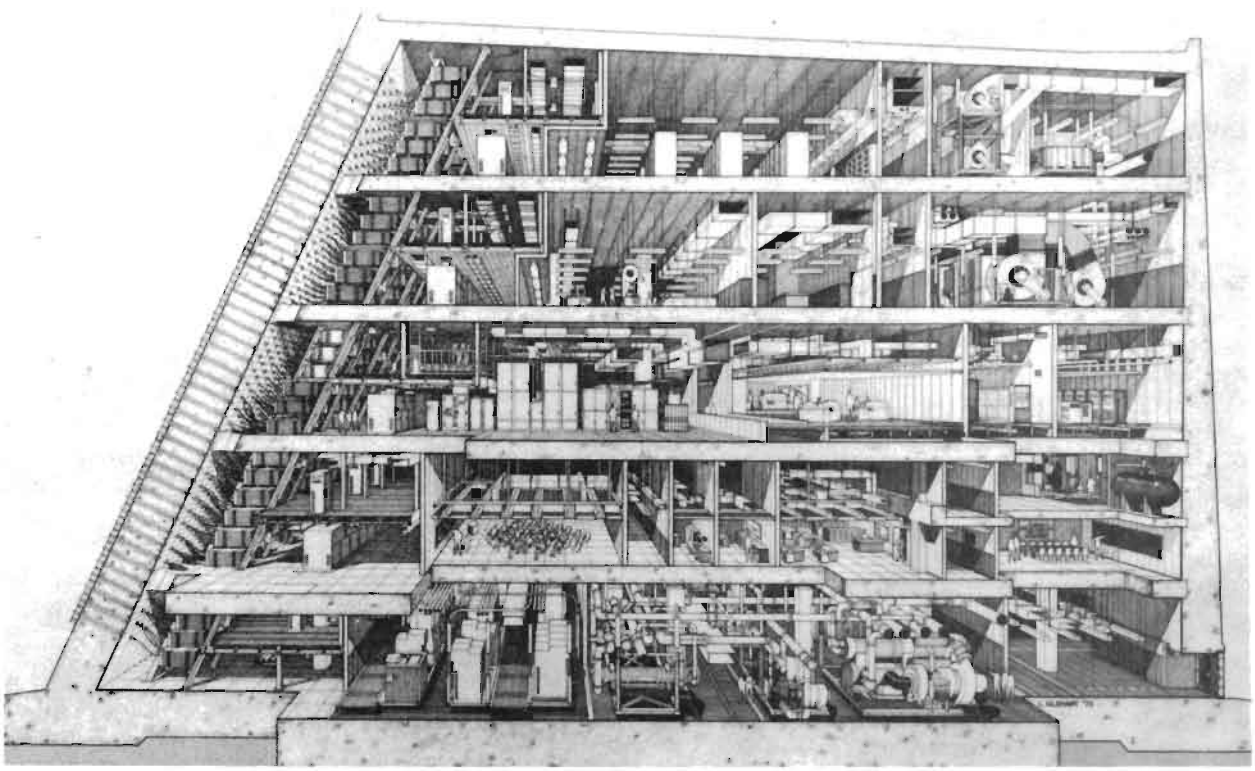
Perhaps happily for the history of architecture, the Boston PAR building never got beyond foundation excavation because of the play of external events that will be described later. Instead, with the suspension, then cancellation, of SENTINEL in early 1969 and the substitution of the SAFEGUARD program thereafter, all attention turned to a single face PAR design to be deployed near MINUTEMAN ICBM bases in the Midwest. This, the definitive PAR design, was a simple, nearly cubical shape of 204 by 213 feet at the base rising over 120 feet, or roughly twelve stores, above ground level. Unlike the MSR, there were no subterranean levels. The antenna face wall sloped inward at 25° from vertical, while the side and rear walls had slight inward runs attributable to reduction in their thickness towards the top. The shape was dictated by antenna dimensions and placement plus internal volume needed to house the essential apparatus.

The SAFEGUARD PAR ultimately built after the SENTINEL design may be the most solidly constructed building in the world, the Egyptian pyramids not withstanding. The antenna face wall (the

"A" wall) measured a uniform seven foot thickness (the original SENTINEL design was ten feet); the side and rear walls tapered from eight feet at the base to three and one-half at the roof. The building shell rested on a base slab eight feet thick. The basic concrete was of 5,000 p.s.i. strength and incorporated a dense mesh of no. 11 gauge reinforcing bars in vertical, horizontal, and diagonal directions. These bars were about as thick as a man's wrist and accompanying photographs testify to their close spacing. About 63,000 cubic yards of concrete and 8,700 tons of reinforcing steel were required.

The interior of the PAR included five full floors with a mezzanine between the second and third levels. Approximately twenty-two feet of clear space separated the floors, this being bridged by an elevator and multiple stairs. The area immediately behind the antenna wall was devoted to the radar phase shifter components and power feed cables, for which the mounting, access, and service aspects involved many special design considerations. Service platforms for the phase shifter, for example, were suspended from the ceiling of the floor above. Passage of the power cables through the floor also necessitated the incorporation of I-beams bolted to the antenna wall interior face to maintain its structural integrity under load. Access to the interior of the building could be gained through two blast locks closed by concrete filled heavy steel sliding doors or through a single story tunnel leading to the adjoining power plant.

Design of mechanical and electrical systems serving the interior of the building presented several unusual challenges because of the need to remove heat generated by the large quantity of electronic equipment contained in the building. Another challenge was to provide a self-adapting power distribution network from the power plant to the electronic equipment which would operate without a flicker under nuclear attack, continuing to supply both precise and conventional power while shifting from commercial to emergency internal power. This could be done in a five stage transition from normal surveillance operations through two degrees of alert to attack and post-attack modes. As with the MSR, the PAR was outfitted with a complete partially buried, partially mounded, electric power plant annexed to the building and connected via a short tunnel. The layout of this power plant and its features were quite similar to the MSR's, save that its five diesel engine generating units produced a maximum of 14.7 megawatts.[34]



CUTAWAY OF A PERIMETER ACQUISITION RADAR BUILDING (PARB)

The MSR, MSR Power Plant, PAR, and PAR Power Plant represented the four major installations required for the SENTINEL System, and their size, sophistication, and significance naturally justified the lion's share of effort devoted to them as the program got underway. By contrast, the design of support facilities at the radar sites, the Remote Launch Sites (RLS's), and the Central Training Facility presented simpler, less expensive, and less pressing needs. Nevertheless, in its own way, each of these was essential to the overall system, and they began to receive some preliminary attention by the Corps and SENSCOM during 1968.

At SENTINEL's inception, it was deemed desirable to make each MSR and PAR site an independent, self-contained entity. Hence, the impressive radar buildings would have to be complemented and supported at each site by a host of humbler auxiliary structures catering to the operation of the base. Housing had to be provided for a garrison of three crew shifts, plus command and administrative staff, and these men also required a separate mess, assembly and classroom facilities, recreational areas, a commissary, and a chapel. Various elements within the complex demanded their own depots and work areas for maintenance. As a secret installation, careful security measures such as sentry stations and fencing were required.

Design for these elements began on 20 March 1968 when a SENSO conference produced agreement on a basis for design of tactical support facilities. Rising costs, however, dictated the deletion or consolidation of some features, such as a chapel and helicopter pad for the Boston PAR. A realistic list of facilities did not appear until July, when the Department of Defense revealed that some "typical building groupings" would include: the headquarters and dispensary building; the barracks and enlisted mess; and "industrial complex area" (technical warehouse, general warehouse, post engineer, and vehicle maintenance); the assembly, classroom, and library facility; the officers' open mess; and sentry stations.[35] Huntsville's principal concern was cost-effectiveness over the site standardization then expected, and this resolved into a choice of prefabrication or conventional masonry construction. On 23 August, a Division study concluded that conventional masonry would be the less costly approach, and design proceeded on this basis throughout 1968.

At the beginning of the SENTINEL program, both SPARTAN and SPRINT missiles were just starting their flight testing, and very little attention had been paid to an operational model of their launch cells. The second successful SPARTAN launch did not take place until the summer of 1968, and the SPRINT program was in about the same status. Thus criteria and design for the requisite launch stations got only limited resources at Huntsville during the SENTINEL period. The design of the cells and the SPRINT RLS's is more properly part of the SAFEGUARD story and will be recounted as part of it.

Much the same relaxed scheduling held true with the SENTINEL training facilities which would not be needed until the program was far downstream. At the inception of the program, it was forecast that a mini-university would grow up at the CONARC Air Defense School at Fort Bliss, Texas, to train the thousands of highly specialized technicians needed to man SENTINEL installations. Preliminary studies for the training facility started in 1968, but Huntsville Division was only peripherally involved with it before the suspension of SENTINEL in February 1969.

The letting of Huntsville Division's first major design contracts for the PAR Building and the PAR Power Plant in June brought increased attention to procurement and contract management procedures for what was looming as one of the Government's biggest and most complex defense shopping ventures ever. Following the Armed Services Procurement Regulation (ASPR) and the Corps' own ER 1180-1-1 Engineer Contract Instructions (an implementation regulation), the engineering divisions and the Procurement and Supply Division began to study the special demands of hardware and fittings for SENTINEL buildings during the spring months of 1968. As in the engineering of the facilities themselves, certain features of procurement for the BMD program emerged that warrant special attention because of their significance to SENTINEL and most especially because of their profound influence on the later history of the Division.

The largest part of Huntsville's procurement for SENTINEL revolved about the concept of Government Furnished Property (GFP). This concept was simply the idea that to achieve a high degree of standardization throughout all seventeen BMD sites, the Government should specify, buy, and have delivered to construction contractors at each location some of the equipment items they needed for completion of a facility. In early planning for a NIKE-X deployment, the Army had determined that for many reasons the degree of standardization within any future antiballistic missile system built had to be considerably greater than for any previous missile weapon system facility construction program. Hence, during the design phase of the SENTINEL (and later

SAFEGUARD) facilities, a primary objective was the standardization of components and construction details within and between the facilities. The ultimate objective was a commonality of equipment and working environment so great that a crewman or technician could be blindfolded, whisked unknowingly from one site to another, and begin work immediately in familiar surroundings. A large measure of this uniformity was achieved. Out of a total of 10,098 separate line items involved in construction of one site (exclusive of the weapon system components), the standardization effort resulted in only 1,703 different makes and models being required. This wide standardization effort was far beyond the norm for the Corps of Engineers, and as a result a significant portion of SENTINEL (and SAFEGUARD) tactical support equipment and system components were purchased by the Government under competitive bidding and furnished to each construction contractor for his installation.

Standardization for a national program as vast, complicated, and expensive as SENTINEL had many advantages over the alternative approach of allowing individual construction contractors the run of the market in fulfilling their contracts on site-by-site basis. A standardization scheme of centrally directed procurement would vastly simplify the inventoy of repair parts, components, and consumables needed at national, regional, and local depots. This in turn would reduce the initial capital outlay for facilities and repair parts and cut the yearly costs of operations and maintenance. With standardization would also come important simplification and cost reduction in training operators and maintenance personnel, in documentation, and in provisioning of test equipment and special tools. Bettering of the maintenance, training, and replacement parts situation would enhance the operational effectiveness of the entire system by reducing "down time," or periods when equipment was out of action due to servicing and increase the flexibility of personnel likely to be moved from site to site. Standardization had great advantages from the view of time, too. Certain items needed for SENTINEL--diesel engine generators and switchgear, for example--required a long lead time for production. Given the short time allowed for installation in the construction schedule, the only solution for meeting deadlines was to standardize many items accross the board.

Having weighed the merits of a Government Furnished Property program and found them worthy, planning began in the spring of 1968 to implement such a scheme. The first step was a series of consultations between engineering personnel and the AE firms to draw up a Master Equipment List from which items might be selected for standardization. Engineering staff then prepared the necessary criteria, specifications, and design for each item standardized. The list of standard items was then forwarded to Procurement and Supply Division for advertisement and award of GFP contracts. In the identification and grouping of items for procurement, items with like characteristics were combined into single identities where practical to do so without compromising a functional requirement while creating anticipated savings. Categories for items were established as standard items, interchangeable items, and limited standard items. These categories provided the basic framework for the GFP procurement effort. Because of the great volume of equipment involved, a data bank was developed to provide an automated basis for tracking GFP equipment items. The status of the Master Equipment List and of each item on it was tracked by means of codes and a data bank entry containing lead times, item characteristics, and specification references. This data bank became the focal point for coordination of construction with GFP equipment delivery schedules and for the in-house administration and tracking of GFP. Schedules were prepared on the basis of anticipated construction progress, and thirty or sixty day "windows" were allowed for delivery on-site.[36]

For the administration of the GFP program, a separate position of assistant division engineer for logistics was established to assist the division engineer in managing all GFP activities. The engineering divisions were charged with implementing and operating the standardization program and with developing criteria, procurement specifications, and design. The Construction Division coordinated and integrated the GFP into the construction network and insured that the special provisions of the construction contracts accurately reflected the items and deliveries identified in the equipment contracts. GFP contracts were solicited, awarded, and administered by the Procurement and Supply Division in conjunction with the Automatic Data Processing Branch.[37]

The first items subjected to GFP procedures were the diesel engine generating units needed to drive the MSR and PAR Power Plants. Development of power plant requirements had begun early in the spring of 1968 and continued until early June. By 12 June, the Division was able to show that if all the power units in the thirteen SENTINEL sites then announced were identical, the cost savings over the life cycle of the units would be $3,665,000. The Division's plans to

standardize the procurement were approved. Anticipating this decision and the complex nature of a diesel engine generator procurement, an Advance Notice to Bidders was issued noting the major specifications that suppliers would have to meet. Then on 21 June, a pre-bid conference was held at Huntsville to discuss the anticipated procurement with bidders. Out of this came a need to delay bid issuance by a week to allow more time to consider the Corps' specifications. These specifications included stiff reliability parameters and an evaluation by Huntsville of the operating costs over a ten year life cycle. Invitations for Bids for three types of medium and low speed diesel engine generators totaling sixty-nine units was duly issued on 16 July and bids opened in Huntsville on 30 July. Seven large industrial concerns offered bids for the generator contract. Unhappily, however, no award could be made immediately because there were protests by the three lowest bidders. The protests were referred to the Comptroller General, who ruled in decision B-165292 on 6 November 1968, that the bid of the principal protestor contained substantial omissions, errors, and lack of other proprieties. The next day, 7 November, power units contract DACA87-69-C-0008 for $26,158,291 was awarded to the Cooper-Bessemer Company of Mount Vernon, Ohio.

Of this 1968 Cooper-Bessemer contract, the Division historian later wrote:

> The award of the generator contract to Cooper-Bessemer on this date was an important milestone for SENTINEL construction. An adverse decision would have caused slippage in the design and construction schedule for Boston and would have imposed a heavy burden on HND to execute a new procurement while at the same time revising other plans to minimize the impact of delay.[38]

The historian was quite correct in assessing the impact of complications. Unknowingly, he was perhaps even more correct in prognosticating that this successful buy would have significant consequences for the future:

> This was a complex procurement action for both HND and OCE. But despite the administrative problems resulting from the protests, it proved to be a sound procurement action which included two fairly new procurement concepts. One of these was the use of life cycle costs as basis for bid evaluation; the other was the inclusion as one evaluation factor the savings that can be achieved through standardization. The experience gained in these areas should be useful throughout the Corps and perhaps to AMC.[39]

Utility to the Corps or AMC aside, what the historian could not then have known was that the Cooper-Bessemer contract paved the way for a series of other massive purchasing efforts that proved immensely beneficial long after SENTINEL passed into history. Most notably, the Postal Bulk Mail Centers procurement mission of 1973-1975 was assigned to, and successfully negotiated by, Huntsville Division largely on the basis of its earlier experience with the SENTINEL (and later SAFEGUARD) GFP program.

While the power units contract was being adjudicated during the early fall, the Division staff launched several other procedures connected with contractual buying or financial savings in contracting. In August, the policy of prequalifying bidders on cirtical construction contracts was instituted. This procedure was covered in ASPR 18-209 and ECI 2-270, and it was recognized as valid by U.S. Comptroller General decision B-135504 made on 2 May 1958. Within the Division, a Prequalification Board was appointed to review the qualifications of all interested bidders, maintain a registry, and administer the local procedures.[40] On the one hand, prequalification would ensure that prospective bidders were fully apprised of bid conditions and specifications, while on the other it gave the Division an opportunity to examine the bidder's construction capacity and capability, financial condition, management, and potential performance without seriously infringing free competition in the marketplace. Contracts of lesser criticality or complexity continued to be advertised across the construction industry, as did those originating with cooperating districts. About the same time, the Division was also granted authority by the Armed Services Procurement Regulation (ASPR) Committee to implement default clauses in constuction and supply contracts, in effect preventing the prime contractor from divorcing himself from liability for delays caused by subcontractors at lower tiers.[41]

Based on past experience with critical projects, it was apparent that for SENTINEL the services of an area counsel and area labor relations officer at the jobsite would be necessary as full time assignments. Although controls and procedures were devised for

coordination with the Hunstville office, the policy for SENTINEL (and later SAFEGUARD) was to streamline by delegating field authority to the utmost. Because Huntsville Division was an operating division and lacked at its inception the contractual authorities normally delegated to district engineers as contracting officers, extra ordinary authorities for the Division's contracting officers and their field representatives (area engineers) were obtained from OCE. Under the SENTINEL program, these special authorities gave Huntsville contracting officers the same authority as district engineers, plus increased authority from none to as much as $500,000 for approval of change orders under "Differing Site Conditions." The authority of the area engineer in change orders was also substantially increased. For the first construction contract award (Boston, Massachusetts), the actual authority delegated from the contracting officer to the area engineer was a maximum of $50,000. Some of these limits were later reduced in the course of the SAFEGUARD program.[42]

Supervision and coordination over contractual legal matters were retained at the Huntsville Division office because of the need for uniformity in decisions made for various SENTINEL job sites and because the extraordinary authorities granted by OCE were contingent upon assurance of such uniformity. Award of basic contracts was at Division headquarters; the same was planned for the conduct of trial of appeals under the disputes clause, should any develop. To enable the Huntsville Division and its area offices to concentrate on construction, arrangements were made with supporting districts for services in processing of claims in the real estate and noncontractual categories.[43]

In addition to contractual and legal procedures, during the fall and summer of 1968 consideration began to be given to initiation of value engineering concepts. During the week of 4-8 November, twenty-five Division employees attended a forty-hour OCE-sponsored course on value engineering concepts, but implementation was limited under the brief period of the SENTINEL program. Value engineering really came into its own under the SAFEGUARD and later programs, where it resulted in extensive savings.

The second and more mundane of Huntsville's major SENTINEL responsibilities was to assist SENSCOM in selecting suitable sites on which to locate installations. On 3 November 1967, the Department of Defense publicly revealed the first ten SENTINEL site locations as Boston, Massachusets; Chicago, Illinois; Detroit, Michigan; New York, New York; Dallas, Texas; Seattle, Washington; Albany, Georgia; Grand Forks AFB, North Dakota; Oahu, Hawaii; and Salt Lake City, Utah. Six months later, on 27 May 1968, three further sites at San Francisco and Los Angeles, California, and Sedalia, Missouri, were added to the list, while sites for Warren AFB, Wyoming, and Malmstrom AFB, Montana, were announced later in the year. Washington, D.C., and Fairbanks, Alaska, were not revealed before SENTINEL was suspended in February 1969.

Immediately after activation, members of Huntsville Division teamed with representatives of ARADCOM and local Corps districts to begin exploratory probes of potential sites in four of the first ten locations, and these explorations multiplied and accelerated throughout 1968. Prime attention centered on finding suitable land in the Boston area, since the Department of Defense had scheduled the first construction to take place there, but most of the first ten sites received some attention's before year's end. The early work progressed smoothly, but during the fall a great deal of confusion arose as the Corps and ARADCOM backed and filled in trying to find qualified sites that did not arouse the ire of local residents and their Congressmen. A very vocal anti-BMD movement emerged after November, and some citizens and municipalities denied rights-of-way access or manifested other acts of antagonism towards the military. When SENTINEL was finally suspended in February 1969, only the Boston PAR and MSR sites had been nailed down with finality.

The 300 or so acres sought for each facility at Boston and other places had to meet rigorous criteria laid down by the Corps in a sixty page "Anti-Ballistic Missile Engineering Criteria Manual for Tactical Site Selection" published by the Huntsville Division in November 1967.[44] This manual outlined a

POTENTIAL SITES FOR SENTINEL DEPLOYMENT IN THE BOSTON AREA.

comprehensive three phase game plan for conducting the selection and validation of sites prior to construction, together with sample reports to be filed and laboratory procedures to be conducted in each area. Phase I was intended to produce general data to enable the System Manager to chose a primary site from among several candidates for each location in the national deployment plan. At Boston, eight potential sites stretched in a rough crescent from Burlington, Camp Curtis Guild, and Peabody northwest of the city northeastward to Swan Pond, Sharpner's Pond, and Hood Pond across the Ipswich and Gloucester on Cape Cod. Here, as elsewhere, the Corps of Engineers was expected to recommend a best site after a visual reconnaissance and study of local land descriptions, climatological factors, utility services, geological data, local construction materials and labor, and transportation and communication lines. These studies even reported typical hourly wage rates, the color and grade of local sand and gravel, airline service, and public radio stations in the area. Most-favored status went to land already in Government hands if conditions were found suitable there.

Phase II was a progressive development from Phase I as concentration on one site evolved. During this period of about three months, exact topographical maps were prepared in two scales and investigations made to determine foundation conditions. Corings, drillings, soundings, and soil samples were subjected to meticulous laboratory analysis to determine porosity, density, geological faults, water tables, and other subsurface conditions. With the completion of Phase II and the approval of the System Manager, acquisition procedures then began. Phase II for Boston was completed in July of 1968, but great difficulty was encountered at Detroit because of ground water. This site had to be changed several times, as did the Chicago sites.

Under Phase III, acquisition of real estate began with the establishment of fee line boundaries and such additional investigations as might prove necessary because of criteria or design changes in the facilities. Actual purchases of land had to conform with Title X of U.S. Code 2662, which specified that Congressional approval was needed to acquire land for defense purposes. In Title X actions, the Corps of Engineers submitted its request to the Secretary of the Army who presented it to the Real Estate Subcommittees of the Armed Services Committees of the Senate and House. The Congressional submission had to include the amount and precise location of the real estate, the last known owners, and its current estimated value, along with justification for the purchase. Thirty days then had to elapse, during which time Congress might hold public hearings or request additional time to consider the Army's needs. If at the end of thirty days Congress had not said otherwise, the Secretary of the Army could take steps to buy the land.

The conduct of real estate transactions was carried out by the local Corps district concerned, with representatives of the district acting as agents for the Secretary of the Army. The Corps was expected to appraise the land through a private appraiser and make an offer to buy at fair market value. Eminent domain was held in last resort, for use only after no reasonable accord could be reached between the Army and landowners.

Finally, before construction could begin community impact studies had to assess the effects of construction and SENTINEL operations on area schools, housing, economics, utilities, local radio, and particularly water supplies. Drawing on past experience with the ICBM construction program, the Corps took two other preliminary steps worthy of note. To avoid the kind of labor troubles that had obstructed the building of ICBM silos, a meeting was held at Boston on 19 November at which the Corps of Engineers and the Department of Labor briefed sixty-four national, regional, and local labor leaders on the forth-coming construction work and the handling of any disputes that might arise.

The same precautions were taken to preclude the possibility of complaints about damages caused to Massachusetts roads that had almost closed down some earlier ICBM work in the Midwest. Alerted by the ICBM experience, Huntsville Division devised an important improvement for the BMD program regarding the use of public roads. In the usual situation a construction contractor had to get to the work site over public roads at his own risk and expense. Any road damage thus created was entirely a matter between himself and the local road authorities. Naturally, accelerated heavy traffic on a large, high priority construction project would invariably lead to premature deterioration of public roads and complaints from taxpayers and local agencies. This could result in an impasse, a slowdown, or even stopping of the work by protective action on the part of local road authorities. The construction of missile sites was of such urgency that in 1961 Congress provided a remedy for reimbursement for excessive damage caused by contractor-generated traffic at missile sites. This legislation was known as the "Fulbright Amendment" and was codified as 23 U.S.C. 210(h). To implement this statute for the BMD program, it was necessary to establish a procedure

between the Secretary of Transportation, Bureau of Public Roads, Military Traffic Management and Terminal Service (MTMTS), and the Corps of Engineers. A special road damage clause was devised and utilized in construction contracts which differentiated between contractor responsibility for normal wear and tear and Government responsibility for excessive damage. The result was highly successful in assuaging the concerns of local public officials about damage to their roads and thus alleviating any need for restrictive actions on their part.[45]

The kinds of activities just outlined obviously depended on close cooperation between Huntsville Division and Corps districts touched by SENTINEL. Site survey and validation was only the beginning of their association--policies and procedures also had to be coordinated for the massive construction to follow, particularly in the constitution and operation of field offices for each job site. The "NIKE-X Mobilization Plan" had forecast a joint relationship between Huntsville and other districts but said little about defining it. This ambiquity persisted until April 1968, when steps were taken to draft a working relationship between Huntsville Division and geographic districts. At a conference hosted by Huntsville Division on 17-18 April, a basic agreement was hammered out concerning the SENTINEL program by representatives from OCE, Huntsville Division, and eight divisions and their subordinate districts. During all-day briefings and discussion on 18 April, a five page "Concept of District Participation" was drawn up providing for command and control, district support of field offices, and other interfaces with the Huntsville Division.

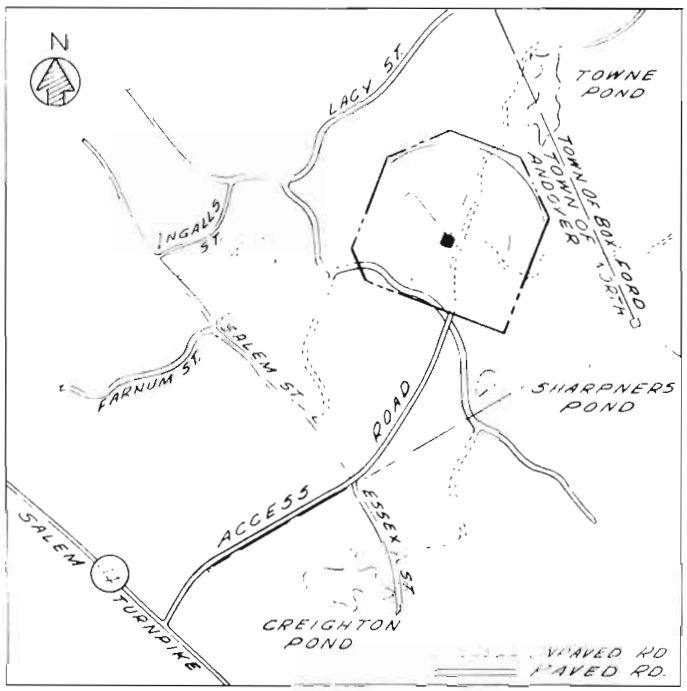
The essence of the April pact was that Huntsville Division would establish a field office headquarters at each SENTINEL site, with the district to dispatch the field office staff to the site. These men would have reemployment rights in their district. The field office slots and funding for them would come from Huntsville and the personnel involved would be responsible to Huntsville Division for the job performance. The districts were asked to administratively and logistically support the field offices and furnish real estate expertise and site exploration services. As site construction progressed, the districts might be solicited for other contributions such as assistance with SENTINEL staff family housing.

Preliminary site activities for the first SENTINEL construction at Boston entered their final stage after 16 August with solicitation of Congressional approval for Title X acquisition of land near Sharpner's Pond for PAR and a plot on Massachusetts National Guard Camp Curtis Guild not far away for the first MSR. On 11 September the Department of Defense confirmed the choice of these sites in a public annoucement, and Congressional approbation under Title X came soon after. The Sharpner's Pond location where ground was first broken two weeks later was a heavily wooded, undeveloped plot close to North Andover. The access road cut into the area ran northeast for one and three-quarter miles off the Salem Turnpike (Massachusetts State Road 114) about four miles southeast of the junction with State Road 125.

The construction undertaken at Sharpner's Pond was scheduled for three stage execution for maximum convenience and flexibility under the tight deadlines prevailing in the PAR design. Each stage entailed a separate contract. Phase I called for cutting the access road, rooting and clearing, and some excavation for the PAR and its power plant. Rock removal, pouring of concrete foundations, some backfill, and connection with related utilities would begin under Phase II later in the winter, with mainstream construction planned for Phase III after the spring of 1969.

Advance notice for Phase I Contract DACA87-69-C-0007 was issued on 22 August, and Invitations for Bids followed on 4 September. The eight bids tendered for first SENTINEL construction were opened uneventfully at New England Division headquarters in Waltham, Massachusetts, at 3:00 PM on 19 September. The low bid of $767,242.50 submitted by George Brox, Inc., of Dracut, Massachusetts, was some $4,500 above Government estimates but was accepted. Brox quickly moved heavy equipment to the site and commenced clearing upon receiving formal contract award and notice to proceed on 24 September.[46] On 15 October, the first SENTINEL area

AERIAL OF SHARPNERS POND PAR SITE



PERIMETER ACQUISITION RADAR

VICINITY MAP

Scale: 1" = 2000'

CONTRACT SIGNING

MISSILE SITE CONTRACT SIGNED--Contract for initial work in North Andover, Massachusetts on Nation's first SENTINEL Ballistic Missile Defense site is signed by Corps of Engineers and George Brox Inc., Dracut, MA. Colonel Lochlin Caffey (seated, left) and George Brox, president-treasurer, ink $767,242 contract. Standing (left to right) George C. Brox, assistant treasurer; Colonel Roy P. Beatty, Deputy Division Engineer for SENTINEL, New England Division, and Frank R. Brox, vice president. Colonel Caffey, Assistant Division Engineer, Eastern Region, Huntsville Division Corps of Engineers, is contracting officer for the Army.

office was opened to administer the contract, with Col. Roy Beatty of New England Division as area engineer. Phase II was begun on 22 January 1969 when Morrison-Knudsen, Inc., of Boise, Idaho, was awarded a construction contract for $2,213,857.00.[47]

The initiation of SENTINEL work in the Boston area was at first received with calm indifference by the local populace. On 25 September, the day after ground-breaking, the Corps conducted a three hour public relations meeting in the auditorium of North Andover High School. About one hundred people and two North Andover selectmen attended. Some resentment at the military's intrusion was manifested, but in general the gathering seemed to go off smoothly. The proceedings were video-taped for later presentation by the National Education Television Network.[48]

The relative tranquility evidenced at North Andover did not prove very durable. Presidential elections were forthcoming in November, and the issue of BMD had been thoroughly aired during late summer and early fall. Concurrent with national electioneering came wide attention and publicity at many locales where BMD sites were to be placed. Some communities took the news that BMD was coming into their backyards with equanimity, but others began to express a smouldering antagonism that grew into outright hostility after October. The causes of this feeling were deeply rooted in the contemporary climate of opinion prevailing in the American public, particularly in intellectual centers and among urban areas of the central and northeastern states. Citizens here and elsewhere were often convinced of the dangers of nuclear warheads in their proximity and were equally

adamant that the risks were disproportionate by comparison with the protection obtained. The debate on both sides was sharpened into a raging national issue because of the escalating Vietnam War, military spending, and the sociological currents in the country during this time. In fact, it was an era of suspicion of government in general and of the military in particular.

The rising tide of BMD opposition was grounded in grass roots feeling and stimulated by a small group of scientists and engineers in the academic-research community. Members of the Federation of American Scientists, a national group of about 2,500 members which had criticized BMD deployment since 1964, were among the foremost spokesmen for the opposition. Soon after the presidential election in November, five Federation scientists formed a "West Suburban Concerned Scientists Group" to fight BMD in the Chicago area. Utilizing the chapter network of the Federation of American Scientists and appeals to Congressmen, the Chicago group took the BMD issue into the public arena, where it gathered momentum in November and December. The focus of the debate shifted to the New England area with the advent of SENTINEL construction there, and the acrimony that ensued soon began to cast uncertainty on the future of the entire program.

Thus it was that 1968 closed with a storm cloud gathering over the SENTINEL deployment. But controversy notwithstanding, the BMD deployment had made great strides in the fifteen months since its announcement. The Army's weapon system contractors had brought the SENTINEL's major radar components from development to production and significantly advanced the data processing equipment. Operation of the prototype MSR on Meck Island began in May 1968, and it later participated in several successful flight tests of SPARTAN and SPRINT missiles. Plans were being laid to push this progress during 1969, along with further site investigations and ground-breakings beyond the Boston installations.

At Huntsville Division, the old year slipped away with a sense of accomplishment about the past and anticipation for the future, all tempered by a growing awareness that SENTINEL's future did not look quite so bright as it had some months before. The Division could take pride in the fact that it had been mobilized, moved to Huntsville, set up shop, and made tremendous progress despite omnipresent pressures of time and fitful shifts of direction. The Division could look with satisifaction on the development of solutions for such challenges as the NEMP and PAR Power Plant placement problems, and it could legitimately anticipate that more such difficulties might be resolved with the completion of shock testing and hardness evaluation during the coming year. Corps personnel at Huntsville Division and its sister divisions had also resolved a mutual plan of action for site work and implemented it at a dozen localities across the nation. If the citizenry's reponse to the arrival of BMD in their neighborhood was not always enthusiastic, hospitable, or even indifferent, the real causes lay in the context of the times and not in the performance of the Corps of Engineers.

CHAPTER I FOOTNOTES

[1]The"Corps of Engineers NIKE-X Mobilization Plan" of May 1967 was actually the product of the four men then making up the NIKE-X Cadre and Planning Group at the Office of the Chief of Engineers.Those four men were: George Fellers,Chief; Richard Malm, Data Processing; Bill McCormick, Engineering; John Kennedy, Construction. In authoring the plan, the NIKE-X Cadre was supported by OCE staff, the Mobile District, and a representative from the Baltimore Distrist. For this information I am indebted to Walter R. Peterson, Mechanical-Electrical Branch, Engineering Division, USAEDH. Peterson was on the staff of the Directorate of Military Construction, OCE, during the 1965-1967 period.

[2]OCE, "NIKE-X Mobilization Plan," p.3.

[3]OCE, "NIKE-X Mobilization Plan," pp. 35-42.

[4]USAEDH-PAO,"Historical Summary FY 1968," II, Documents, pp. 44-45. Because the bulk of material for this chapter has been drawn from the Division's "Historical Summary FY 1968" and "Historical Summary FY 1969," individual citations have been made only for direct quotations and for materials that are not drawn from the "Historical Summary."

[5]Draft Regulation No. 10-1-, Organization and Functions, U.S. Army Engineer Division, Huntsville, OCE for USAEDH, n.d., attached to ltr, OCE to Division Engineer, Huntsville, 26 Dec. 67, sub: Organization and Functions; ltr, USAEDH to Chief of Engineers, 17 Jan 68, sub: Control of Organization and Functions; ltr, OCE to DivisionEngineer, Huntsville, 16 Aug 68. Historical Records File, Management Analysis Branch, USAEDH.

[6]Text of the Memorandum of Agreement is in USAEDH-PAO, "Historical Summary FY 1968," II, Documents, pp. 81-82.

[7]I am greatly indebted to Dewey Rhodes, Chief of the Manpower Management Branch, Personnel Office, USAEDH, for providing much valuable information about the manpower aspects of the Division's history. Much of this information clarified and elaborated the information available in the "Historical Summary" for 1968 and 1969.

[8]A brief vita on John Coony can be found in USAEDH-PAO, "Information Bulletin," I, No. 5 (23 Dec. 1968), p.2.

[9]A brief vita on Joe Harvey can be found in USAEDH-PAO, "Information Bulletin," II, No. 3 (9 June 1969), p.2.

[10]A brief vita on Bernard Trawicky can be found in USAEDH-PAO, "Information Bulletin," II, No. 2 (9 May 1969), p.2.

[11]A brief vita on Emil Vuch can be found in USAEDH-PAO, "Information Bulletin," I, No. 1 (19 Aug. 1968), pp. 1-2.

[12]BMDSCOM, **Bell ABM Project History,** pp. I/44-I/45.

[13]Ibid.

[14]This is inferred from the Soviet threat capability mentioned in BMDSCOM, **Bell ABM Project History,** pp. I/44-I/45, and definitively stated to the author in an interview with R.L. Phillips, Project Management Branch, USAEDH-ED, on 2 May 1977.

[15]The reader should again be reminded that the hardness criteria for the SENTINEL facilities remains secret. This includes such features as overpressure and survival in "button-up" mode after nuclear attack.

[16]See, for example, the figures mentioned by Michael London, Associate Editor of **Space/Aeronautics** magazine, in "Safeguard: Is There a Choice?," **Space/Aeronautics**, November 1969, pp.48-55.

[17]The best unclassified source of information on both SENTINEL and SAFEGUARD facilites is "SAFEGUARD: A Step Towards Peace," published by USAEDH in 1973. The Wyle Laboratories contract of November 1969 was DACA87-69-C-0003 in the amount of $59,158 and closed at $71,560.

[18]USAEDH-PAO, "SAFEGUARD: A Step Toward Peace," p. 21.

[19]Ibid., pp. 21-22.

[20]Ibid., pp. 22-23.

[21]Ibid,. pp. 22-23. Also see "Historical Summary FY 1968," I, Narrative, for the development of these solutions during 1968.

[22]USAEDH-PAO, "SAFEGUARD: A Step Toward Peace," pp. 22-23.

[23]Interview with R.L. Phillips, AE Contracts Section, USAEDH-ED, 2 May 1977.

[24]Contract DACA01-67-C-0010 in the amount of $332,746.00. Closed after thirty modifications on 14 August 1972 for $8,270,712.50.

[25]A list of the major design studies and reports in this line of NIKE-X research back to 1964 can be found in the "Historical Summary FY 1968," II, Documents, xiv-xxi.

[26]Contract DACA87-68-C-0001 was closed in June 1971 for a total of $18,248,706.78.

[27]This was Contract DACA73-68-C-0006, closed in October 1971 after seventeen modifications for $5,566,448.25.

[28]On the design of the MSR and MSR Power Plant as they were incorporated in the SAFEGUARD System, see USAEDH-PAO, "SAFEGUARD: A Step Toward Peace," pp. 9-11, 14-17.

[29]USAEDH-PAO, "Historical Summary FY 1968," I, Narrative, pp. 24-25.

[30]Interview with R.L. Phillips, AE Contracts Section, USAEDH-ED, 2 May 1977.

[31]This was Contract DACA87-68-C-0011, closed after twenty modification on 30 August 1972 for $12,531,049.

[32]This was Contract DACA87-68-C-0012, closed after twenty-two modifications on 27 June 1973 for $5,689,838.19.

[33]USAEDH-PAO, "Historical Summary FY 1969," I, Narrative, p. 41.

[34]USAEDH-PAO, "SAFEGUARD: A Step Towards Peace," pp. 5-8, 14-17, 20-23.

[35]USAEDH-PAO, "HND Liaison Bulletin," I, No. 1, p. 2.

[36]USAEDH-PAO, "Government Furnished Property (GFP) After Action Report: SAFEGUARD Ballistic Missile Defense Program," April 1977, pp. 3-7; Memo to the author from Thor S. Anderson, Chief USAEDH-PS, 20 June 1978, concerning specifics of SAFEGUARD GFP program.

[37]Memo to the author from Thor S. Anderson, Chief, USAEDH-PS, 20 June 1978.

[38]USAEDH-PAO, "Historical Summary FY 1969," I, Narrative, p. 47.

[39]Ibid., pp. 47-48.

[40]USAEDH-OC, "History of the Office of Counsel," First Year (Oct. 1967- Oct. 1968), p. 8.

[41]USAEDH-PAO, "HND Liaison Bulletin," I, No. 2 (6 Sept. 1968), pp. 2-3; USAEDH-OC, "History of the Office of Counsel," First Year (Oct. 1967- Oct. 1968), pp. 12-15.

[42]Memo to the author from Emil Vuch, USAEDH General Counsel, 25 Oct. 1977.

[43]Ibid.

[44]USAEDH-ED, "Anti-Ballistic Missile Engineering Criteria Manual for Tactical Site Selection," Huntsville, Alabama, November 1967.

[45]USAEDH-PAO, "HND Liaison Bulletin," I, No. 2 (6 Sept. 1968), p. 2; Memo to the author concerning special SENTINEL and SAFEGUARD legal actions on the problem of contractor traffic from Emil Vuch, USAEDH General Counsel, 25 Oct. 1977.

[46]USAEDH-PAO, "Historical Summary FY 1969," II, Documents, p. 42.

[47]Ibid., pp. 10 and 42.

[48]This meeting and SENTINEL activities in general were widely reported in local newspapers such as the **Boston Globe,** Lawrence **Eagle-Tribune,** Lynn **Item,** and Wakefield **Item.** The author's studies have been greatly facilitated by a mammoth eight-inch thick scrapbook of newspaper clippings maintained by the office of Col. Roy P. Beatty, area engineer for the Boston PAR job. This scrapbook is currently held in the Historical Records File, Public Affairs Office, USAEDH.

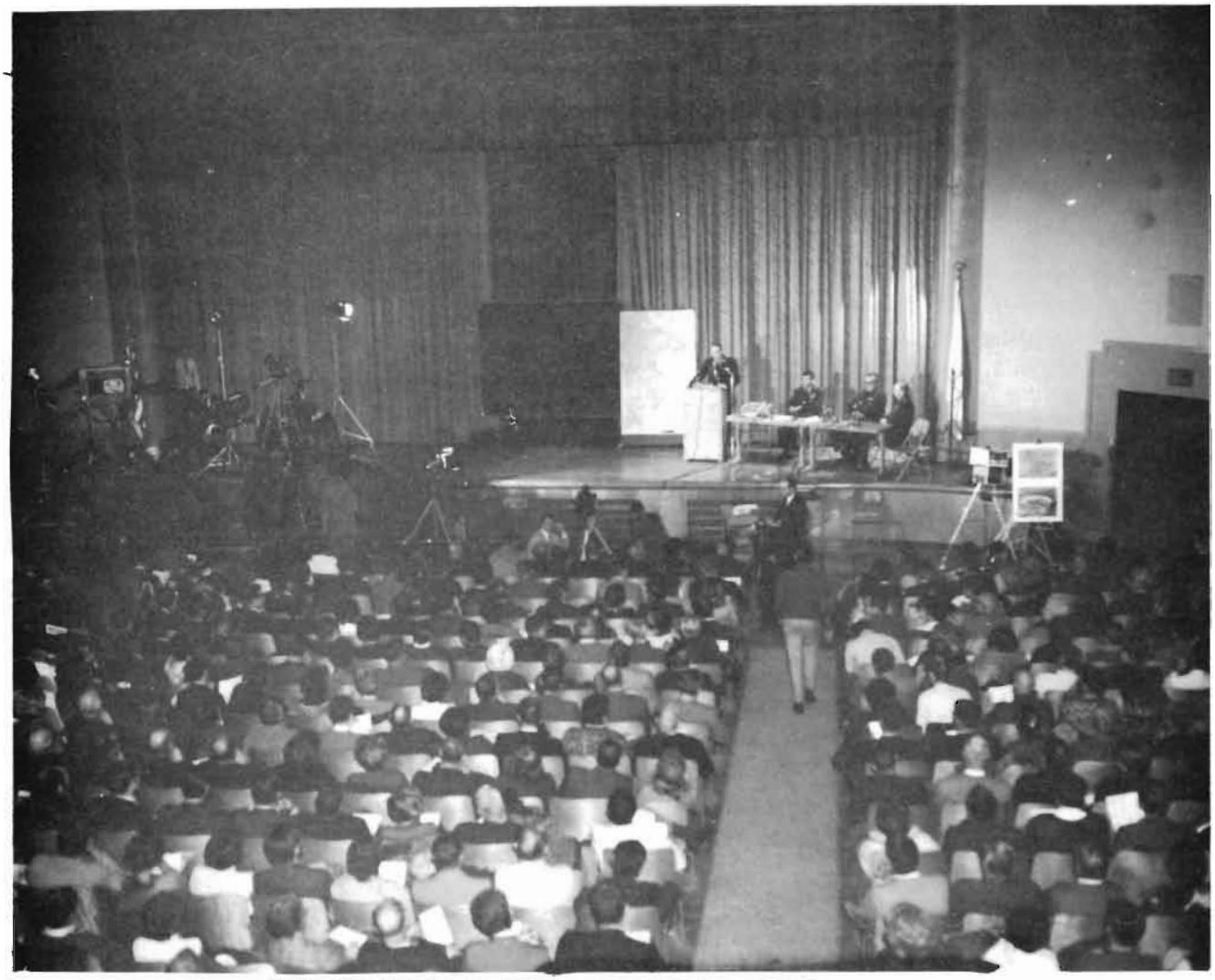
CHAPTER II

TRANSITION TO SAFEGUARD

Throughout the fall of 1968, opposition to the deployment of the SENTINEL ABM System steadily grew more extensive and more vocal, becoming a significant citizens' movement in the north-central and New England states as well as in some smaller isolated enclaves on the West Coast. The anti-BMD movement especially began to make itself heard after the adjournment of Congress in late October and the Presidential election of early November. The change in national leadership from Democratic to Republican after Richard Nixon's election seemed to make no difference to opponents of BMD, and during December and the first month of the new year the anti-BMD current continued to swell in number and clamor, without as yet noticeably affecting public policy. Throughout most of 1968 and before, the opponents of BMD had mostly been drawn from the academic and scientific community, clustering around the American Federation of Scientists and such figures as Dr. Herbert York, Dr. Jerome Wiesner, Dr. George Rathjens, Dr. Hans A. Bethe, and Dr. Richard L. Garwin. [1] A number of these men, such as Wiesner, who had been Director of the Office of Science and Technology under Presidents Kennedy and Johnson, and York, who had twice served on the President's Science Advisory Committee, had been official advisors in Government agencies. Others, like Bethe and Rathjens, were highly placed in academic circles, or, like Garwin, directed private research "think tanks." Now, in part because of their leadership, in part because of widespread local concern about the worth and dangers of the SENTINEL, the anti-BMD movement spread to the grass roots of American life. One general indicator of the nature and appeal of the movement can be seen in the fact that **Scientific American,** a distinguished semi-popular journal bridging the academic and lay communities, published no less than three articles related to strategic arms and the BMD question between March 1968 and August 1969.[2]

Interest in BMD was particularly strong in the New England area, where SENTINEL construction had gotten underway in September 1968. Here the escalation of public attention in the three months between September 1968 and January 1969 can be gauged by two public relations meetings sponsored by the Corps of Engineers to explain SENTINEL constuction around Boston. The first meeting held by the Corps at North Andover, Massachusetts, on 25 September to inform residents about the PAR site at Sharpner's Pond had resulted in some local newspaper publicity and an attendance of about 100 persons. The tone of this assembly was concerned but courteous, and it came and went without discernable consequences.

The Corps' second meeting, held in the Reading High School auditorium at Reading, Massachusetts, on the evening of 29 January was a wholly different event in almost every way. Widely heralded by notices in local papers and in the Boston press, the Reading meeting was forecast by local police to attract as many as 5,000 persons. As it happened, attendance was considerably reduced by a sudden winter blizzard a few hours before the meeting which dumped several inches of snow on the area. Despite this inclemency, Dr. Rathjens and other out-of-state BMD opponents, together with an estimated crowd of between 1,000 and 1,300, packed into the auditorium and adjoining cafeteria to hear Huntsville Division Engineer General Young's presentation. By contrast with the earlier North Andover meeting, the audience was unsettled, dubious, and outspoken. On several occasions the General was interrupted by questions, comments, and catcalls, which interjections were often followed by loud and prolonged applause if they were to the liking of skeptics. General Young responded to the barrage of questions with answers from his own knowledge, "question-and-answer" briefings, and information from SENSCOM. The meeting lasted three hours and was widely covered by the national and local press as well as by radio and television, one three hour videotape recording later appearing on educational television. The **Boston Globe** reported the next day that some 500 residents had stayed after the meeting to organize a further local opposition effort.[3]



READING, MASS. MSR PRE-CONSTRUCTION MEETING 29 JANUARY 1969

A most important consequence of the Reading meeting became apparent soon afterwards when Massachusett's influential Senator Edward Kennedy was drawn into the opposition movement. As the **New York Times'** John W. Finney later reported, immediately after the Reading meeting "ended on an inconclusive contentious note," former Kennedy advisors Wiesner, Rathjens, and Richard N. Goodwin contacted the late President's younger brother by telephone and urged him to join the BMD opposition.[4] This Senator Kennedy did. The next day, 31 January, he wrote to Secretary of Defense Melvin R. Laird that the SENTINEL System was technically deficient, dangerously sited, unduly costly, and deleterious to domestic priorities as well as to prospects for an arms agreement with the Soviet Union.[5] The Kennedy letter touched off extensive Congessional debate on 4 February, which eventually culminated in threats by the House Armed Services Committee to cut off approval for SENTINEL land acquisition unless the Administration reviewed the entire BMD program. On 6 February, Secretary of Defense Laird announced just such a Presidential review. Pending the outcome of the review, all SENTINEL activities were suspended.

The Presidential review lasted five weeks, during which time the President and his chief advisors weighed the fate of the SENTINEL System. Their

principal options were to expand the SENTINEL into a "thick" anti-Soviet system, to continue the Johnson Administration's "thin" SENTINEL unchanged, to modify the SENTINEL deployment by concentrating it in Midwestern ICBM fields, or to terminate any kind of BMD deployment altogether. The first two choices were politically and economically untenable under prevailing conditions of the Vietnam War and socio-political criticism. The last seemed ill-advised because of the military advantages offered at the time when the Soviets were introducing their silo-cracking SS-9 missile with multiple warheads and most especially because the United States would have need of such a system as a "bargaining chip" in arms limitations discussions with the Soviets. The possibility of such negotiations had often been broached during 1968, but their probability looked increasingly good early in 1969.

At his fourth news conference called at the White House on 14 March President Nixon announced the long awaited results of the review and his decision to significantly modify the nations BMD deployment scheme. He noted that after a study begun in February, he had concluded that the previously adopted SENTINEL program should be redirected into a terminal defense network primarily oriented towards protection of the country's strategic forces. The new deployment, the President said,

> is a safeguard against any attack by the Chinese Communists that we can foresee over the next 10 years. It is a safeguard of our deterrent system, which is increasingly vulnerable due to the advances that have been made by the Soviet Union since the year 1967 when the SENTINEL program was first laid out. It is a safeguard also against any irrational or accidental attack that might occur of less than massive magnitude which might be launched from the Soviet Union.

The President likewise noted some things that the new system would not do. It would not provide a city defense, because "there is no way that we can adequately defend our cities without an unacceptable loss of life." Under either a "thick" or "thin" area defense, prohibitive civilian casualties were to be expected, and accordingly, the best alterntive was to defend the deterrent forces. Other alternatives, those of continuing research and development, of doing nothing, or delaying for some months, could not be countenanced because of the lead time necessary in meeting the Soviet threat that would exist in 1973. Also, increasing the nation's strategic capability through additional submarines, MINUTEMEN, or bombers had been rejected because, the President reasoned, it would prove provocative and might escalate the arms race. Lastly, the new system differed significantly from SENTINEL in one other way. Unlike the former program, which was dependent upon a fixed deployment schedule, the new system was to be subjected to an annual reappraisal in the light of changes in the threat to the nation, progress in arms control, and advances in BMD techniques.[6]

As usual with such conferences, the President did not further elaborate on details of the new system's cost, deployment schedule, site locations, or equipment provisions. Many of these questions, however, were answered later in the day at a Pentagon press briefing offered by Deputy Defense Secretary David Packard.

Standing before a large national map entitled "Modified SENTINEL," Packard pointed out that the new BMD system would involve a total of twelve sites, each of about 300 acres. The first two would be located at Grand Forks AFB, North Dakota, and Malmstrom AFB, Montana, with follow-on sites in the upper Northwest; central and southern California; Warren AFB, Wyoming; Whiteman AFB, Missouri; the Michigan-Ohio area; southern New England; Washington, D.C.; Dallas, Texas; and the Florida-Georgia area. Additional sites might be added later to generate a limited area defense for all fifty states.

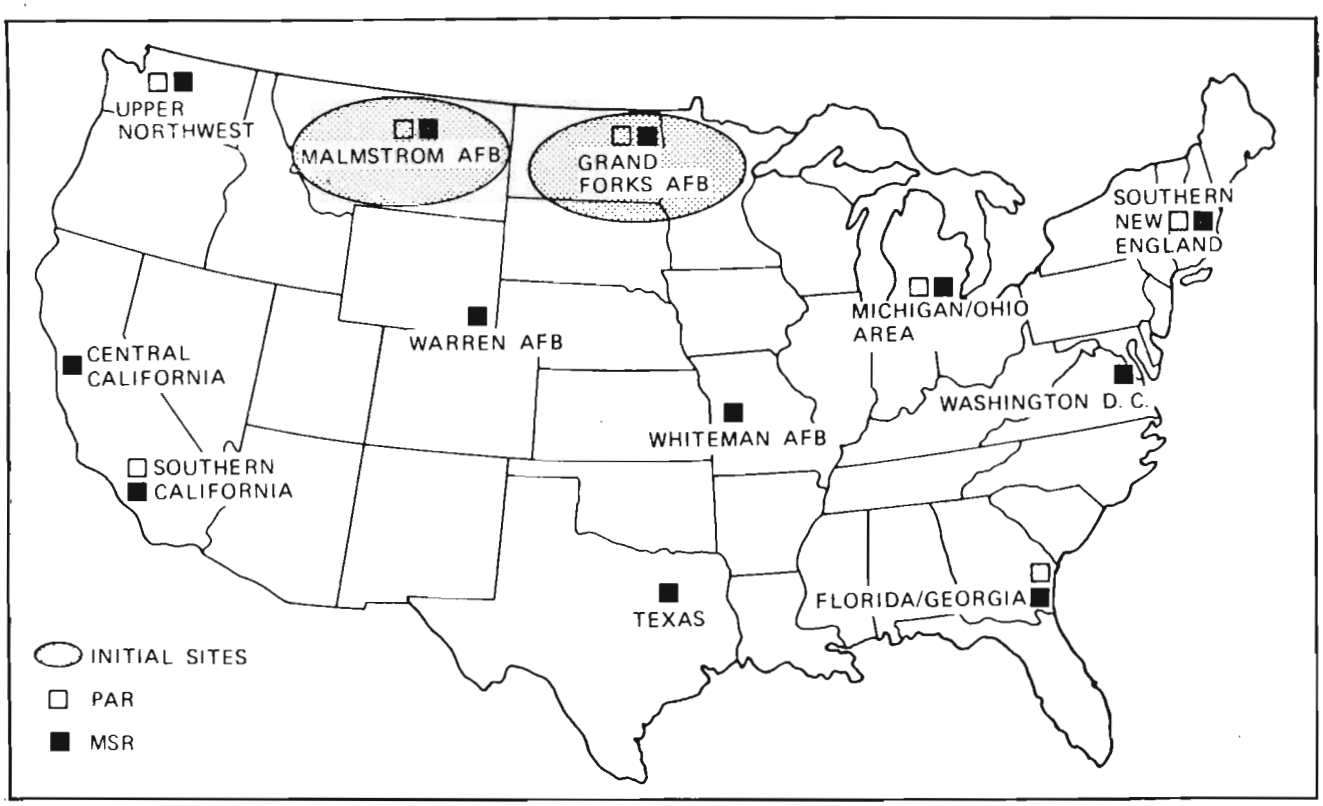
The "Modified SENTINEL" featured two kinds of installations: SENTINEL-type PAR's close by MSR's, and MSR's sited by themselves. Seven PAR's with a total of eleven faces located around the periphery of the country would generate an all-around search capability, with special surveillance against submarine launched attacks that were formerly an Achilles Heel of the SENTINEL System. These seven PAR sites were combined with an MSR facility in the near vicinity to defend both the PAR and the region's deterrent forces. Five other sites, mostly in the interior of the country, featured MSR's only. All twelve MSR's were to have four active faces for 360 degree coverage and all twelve were to be armed with both SPARTAN and SPRINT missiles, but none of these were to be in proximity to heavily populated urban areas. The single exception, an MSR near Washington, D.C., was necessary to protect the "National Command Authorities" of civilian and military leaders.

Construction of all twelve sites promised no great savings over SENTINEL, in part because of inflation. Packard estimated that to complete ail twelve sites soon after 1975 would entail a ballpark cost of between

$6 and $7 billion, or $1.5 billion more than the SENTINEL System. Initial deployment was to begin with construction of a single face PAR and a four face MSR near the MINUTEMAN fields at Grand Forks AFB, North Dakota, and Malmstrom AFB, Montana. About $2.1 billion would be needed for these two sites, with about $800 million already in hand for SENTINEL work. These figures did not include the cost of warheads, which had to come out of funding for the Atomic Energy Commission, or costs of research and development, already accomplished in large measure.

The two initial sites at Grand Forks and Malmstrom comprised an intermediate Phase I, beyond which lay multiple options for Phase II in conformity with the annual evaluation promised by the President. If the Soviet ICBM force continued to grow, Phase IIA could be chosen by building the planned MSR sites at Whiteman AFB, Missouri, and at Warren AFB, Wyoming, and by beginning a PAR-MSR complex at Washington, D.C. Phase IIB called for the activation of all twelve sites if the Soviet threat seemed to be materializing around submarine launched missiles, and Phase IIC also involved twelve sites with fewer missiles to counter a Chinese ICBM expansion.[7]

Probably taking their cue from the working of the President's remarks, the press and media began referring to the "Modified SENTINEL" as the SAFEGUARD System, and the military followed suit officially on 25 March.[8] The BMD program thus launched would stretch across the next six years, ultimately producing two construction starts and one site completed after implementation of the "Agreement on ABM Systems" signed with the Soviet Union in May 1972. Though nearly as abortive as its predecessor, in retrospect the inauguration of the SAFEGUARD program represented a shrewd effort on the part of the Chief Executive and the military to balance out diverse social and political criticisms with economic and diplomatic considerations while still giving the country an effective BMD system. The resulting SAFEGUARD defense focus was shifted to terminal or point protection for national strategic forces with area defense for the population a secondary benefit. This objective was a retrenchment from the ambitious goals of SENTINEL, but it appeared more feasible and attainable and could be advertised as such. SAFEGUARD should have been more effective in dealing with sea-based assaults, and it did move controversial nuclear warheads away from



populous centers while costing about the same as its antecedent. Additionally, the flexible deployment schedule also helped to take the wind out of some anti—BMD forces which had criticized the rigidity of SENTINEL programming. Finally, construction of SAFEGUARD preserved a BMD program-in-being which strengthened the American hand at any future arms limitation talks.

Despite its apparent advantages over SENTINEL, the SAFEGUARD program immediately encountered stormy weather which mounted to hurricane proportions during Congressional debates of the spring and summer. No sooner had the SAFEGUARD decision announced that the **New York Times** indicted it editorially, deeming it "the useless 'Safeguard'" and "an unconvincing package" as "wasteful as the pyramids and not much more useful." "It is not necessary," the **Times** went on, "for a majority of the Senate to remain in bondage to the Pentagon pyramid-builders in order to show that they care about the defense of this country."[9] Pugent sentiments like those of the **Times** could be heard in every quarter in 1969, but as Benson Adams has written in **Ballistic Missile Defense,** it should be understood that at this time the BMD issue was rarely weighed objectively on its own merits or faults.[10] This was an era of draft-card burning, campus protests, "flower children," outspoken clergy, and wide social discontent; in it, BMD was a tangible issue to be grasped and argued amid a powerful flux of despair, frustration, and questioning surrounding the Government, the military, national priorities, the arms race, inflation, and the values of a technological society. As much as for its intrinsic worth, BMD was debatable because it cut across all these sensitive areas as few other issues did.

The traditional American political forum for such controversies is the Congress, and debate there over BMD and the proper way to implement it began to heat up in early February. The Presidential review, 14 March news conference, and announcement of SAFEGUARD did nothing to quench Congressional interest, which mounted throughout the spring and early summer to reach a climax with decisive votes in August. During this period those pro and con continued to organize their forces and lobby their elected representatives; two typical organizations in the thick of things were the Citizens Committee for Peace with Security and the National Citizens Committee Concerned about the Deployment of ABM. Each of these and others like them also continued to have the support and encouragement of prominent personages from all walks of life, many of whom were heard in prolonged spring hearings before both the Senate Armed Services Committee and the Senate Foreign Relations Committee.[11] The hostility of influential Senators in the latter committee made Senate passage of necessary authorizations and appropriations unpredictable until the final votes were taken.

Since both houses of Congress had to approve both authorizations and appropriations bills, this gave BMD opponents four chances to halt the program. Additional opportunities could have come in the conference committee had the House and Senate been unable to pass identical bills. The crucial Senate debate began on 9 July with consideration of the FY 1970 Defense Authorization Bill. On 17 July, the entire Senate met in a rare closed session to allow opponents to introduce classified Pentagon information bearing on the Soviet SS-9 threat. By the fourth week of debate, it was clear that the rest of the country, like the Senate, was closely divided on the issue--a Gallup poll of late July showed that 58 percent of the sample described themselves as either uninformed or undecided on the issue.[12]

On 6 August voting began. Senator Margaret Chase Smith's first amendment to bar all SAFEGUARD spending was defeated 11 to 89; her second amendment, effectively cancelling SAFEGUARD but permitting other BMD research, was narrowly defeated by a 50 to 51 vote in which Vice-President Spiro Agnew cast the deciding ballot. A similar Cooper-Hart Amendment was also defeated 49-51, and the next day, 7 August, an amendment by Senator McIntyre was defeated 27 to 70. After defeat of these amendments in the Senate, the bipartisan coalition opposing SAFEGUARD steadily lost ground. In reality, the 6 August vote was the highwater mark of BMD opposition in the Congress. On 18 September 1969, the Senate finally approved the $20 billion Military Authorization Bill, followed in October by the House of Representatives. Later, both House and Senate passed a $69.9 billion Defense Appropriations Bill containing $1.5 billion in funds for SAFEGUARD expenditures in FY 1970.[13]

Closely linked with the Great Congressional BMD Debate of 1969 was another development that would become even more crucial for the future of SAFEGUARD. As early as 1 July 1968, when signing the Nuclear Proliferation Treaty, President Johnson agreed to hold arms limitations talks with the Soviet Union, with BMD to be on the agenda. However, because of Vietnam, the Czech invasion, and presidential elections, these talks had never gotten off the ground. On the day of Nixon's inauguration, the

Soviets renewed their interest in starting strategic arms negotiations. Preliminary discussions were delayed during the Congressional debates, but on 25 October 1969, near the end of the Congressional actions, the Soviets agreed to come to the table. The first preparatory talks commenced at Helsinki, Finland, on 17 November 1969. Thus, having weathered the test of Congressional approval during the summer, the SAFEGUARD program's future remained cloudy because of diplomatic considerations at the highest level.

The Presidential review, Congressional actions of the summer and fall, and the opening of preliminary arms talks had important consequences for the entire Army infrastructure that was carrying out the development and deployment of the United States' BMD system. The outcome of the Presidential review as announced on 14 March made it clear that the SENTINEL program was now a thing of the past and that its SAFEGUARD successor would demand a certain redirection of effort to accommodate the revised tactical approach and modified scheduling. Whether or not the new BMD program would actually materialize, however, was contingent upon Congressional confirmation for the Chief Executive's decision, and as has just been seen the necessary final funding votes were not taken until the mid-fall of 1969. Hence, the SAFEGUARD program was inaugurated under an atmosphere of suspense and uncertainty, an atmosphere that persisted strongly up to the crucial Senate votes of 6 August and to a diminishing degree thereafter. In effect, during the spring, summer, and fall, members of the SAFEGUARD community had to assume that their program would be authorized by the Congress and proceed in that belief while refraining from major decisions and commitments until their assumptions were vindicated by legislation. At Huntsville Division, the constraints and delays due to Congressional debate were acknowledged to an attentive staff a few days after the historic Senate vote of 6 August, when Division Engineer General Young wrote in the unit's "Information Bulletin" that

> The delay incurred in reaching a vote in the Senate has in turn caused delays in some of our planned activities and we are now faced with getting those things done in a compressed period of time. Furthermore, we will continue to be constrained in some desired actions until the Congress has actually passed and sent to the President the legislation covering the authorization and appropriation bills. None the less, we will be expected to meet schedules which were established with earlier Congressional approval in mind.[14]

In the next issue of the "Bulletin" in September, General Young again observed the importance of the debates and votes then being carried on in the houses of Congress and outlined to Division personnel the complex legislative process essential to the passage of DOD budgetary requests from their introduction to Presidential signature.[15]

Even without the assurance of final Congressional approval, though, the Army could, and did, initiate several steps to expedite the smooth transition to SAFEGUARD. Fortunately for all concerned, the adjustment was not nearly as rude as that which might have come from a more radical deployment scheme. Ten days after the Presidential announcement, the Department of the Army officially named the modified BMD system the "SAFEGUARD Ballistic Missile Defense System" and instituted corresponding changes in organizational acronyms throughout the SENTINEL infrastructure. In most cases, the former "SEN-" prefix was replaced with "SAF-" in acronymic references. The former SENTINEL System Manager, for example, now became SAFSM, while his System Office was designated SAFSO and the former SENTINEL Systems Command became SAFSCOM. In terms of organizational or personnel changes, however, the new designations were merely cosmetic, for the basic structure, command relationships, and mission assignments remained very much the same as under the former SENTINEL program. This was certainly true at Huntsville Division, which continued to serve SAFSCOM in the same way that it had previously served SENSCOM. As will be seen shortly, the Division's organization and personnel also remained almost unaffected, while its manpower requirements were somewhat reduced from SENTINEL projections.

A significant part of the Division's mission under the SENTINEL program had been concerned with site selection and validation, and most of this responsibility was uninterrupted by either the Presidential review or the new deployment under SAFEGUARD. Immediately after the President's review was announced in early February, the SENSM directed that in the interim site validation and surveys should continue at Chicago, Detroit, Grand Forks AFB, Malmstrom AFB, Albany, Seattle, San Francisco, and Los Angeles--all understood to be likely candidates in any future BMD network. Correspondingly, the work at Oahu, Hawaii; Dallas,

Texas; and in Alaska was suspended in the likelihood of having little utility and low priority in the eventuality of a modified SENTINEL effort.[16] These judgements were largely confirmed after the announcement of SAFEGUARD sites on 14 March. The emphasis of ARADCOM reconnaissance teams, Huntsville Division, and the Omaha District then turned towards completing the investigations and surveys at Grand Forks and Malmstrom for early construction there.

Likewise, after 14 March, it was necessary to close down construction at the Sharpner's Pond PAR site at Boston, now redundant to SAFEGUARD, and to commence contract termination procedures there. Upon receiving notice of the Presidential review of 6 February, Huntsville Division directed George Brox, Inc., to suspend all operations except those necessary to maintenance of the access road, the site, and attendant office buildings. After the decision for SAFEGUARD was announced, the SAFSM directed Huntsville Division to terminate the Morrison-Knudsen contract for Phase II and to freeze the Brox contract for the excavation and access road until further notice. The Brox contract was then about 90 percent complete and the Morrison-Knudsen contract scarcely underway. About $3 million had been spent on Boston construction by the time of termination. Total SENTINEL termination expenses for Huntsville Division were estimated in May 1969 at $16.5 million.[17] The closeout plan was largely left to OCE and the New England Division since it basically

SHARPNER'S POND AFTER SUSPENSION OF WORK, MARCH 1970

involved real estate negotiations.[18] Local residents exhibited considerable interest in restoration of the site and its alteration into a recreational area, and in May a proposal to this end was made by the town of North Andover and the Massachusetts Department of Natural Resources. The proposal was forwarded to OCE for consideration, and ultimately the former BMD site became a Massachusetts State Park. The excavation for the PAR Building, now filled with water, became a peaceful playground for anglers, boaters, and swimmers rather than a bastion in the country's defense.[19]

Early in the transition to SAFEGUARD, Huntsville Division also had to examine the implication of the new program for its long-range procurement practices, especially those in the extensive GFP operation previously mapped out for SENTINEL procurement. Of particular concern were the complications introduced in standardization and procurement by SAFEGUARD's phased concept, annual program review, and extended deployment schedule. In view of these factors, SAFSCOM was requested to reaffirm that standardization remained an objective of the revised program. This reaffirmation for standardization was soon forthcoming, along with renewal of authority from OCE for use of multi-year procurement contracts.

In connection with this, steps had to be taken to revise the large diesel engine generator contract awarded the past November for SENTINEL power plants. On 28 March, two weeks after commencement of SAFEGUARD, Cooper-Bessemer was asked to cease preparation and submittal of their shop drawings and were advised that a delay of about twelve months was to be expected in delivery of the first year's requirements. They were also informally requested to extend the Government's option for additional generators by one year. Discussions then ensued to conclude a supplemental agreement covering the revised delivery schedule, special escalation clause, options, and progress payments. On 6 June, the Company submitted a proposal in the amount of $879,000 to realign its supply contract, and it agreed to extend pressing option deadlines until 1 October to allow for Congressional action on the BMD program. After long and complex negotiations, an agreement was consummated by Contract Modification 008 on 21 October 1969. Savings due to the reduced number of units required were offset to a degree by inflation and other factors so that the net change in contract amount was a small decrease.[20]

The announcement of President Nixon's review and the subsequent transition to SAFEGUARD also had significant, but not profound, influence on the design of BMD facilities. While awaiting news of the review's impact on facility design, Huntsville Division's engineering staff continued with work on SENTINEL-type designs required for the Boston PAR and MSR. The hectic pace of the past few months, however, abated during February and March as overtime was slashed to reduce costs pending outcome of the review. Despite the uncertainty surrounding the continuation, modification, or even cancellation of SENTINEL, substantial progress was made in completing design of the PAR Building. On 18 February 1969, the SENTINEL System Configuration Control Board "baselined" the PAR Building's criteria, in effect giving them the stamp of final approval. Despite this formalization of general agreement on a design, though, several major design features remained either unresolved or in need of more effective solutions.

One of the thorniest problems still lingering in PAR Building design was the antenna face wall, or "A" wall, and in particular the manner in which power cables from the exposed antenna elements would be fed back through the thick concrete wall to the phase shifters inside. "Can it be built?" and "There must be a better way!" were typical remarks emanating from those who saw the preliminary design and scale model originally favored by BTL, the prime weapon system contractor. BTL had proposed an extremely complicated scheme requiring about 6,300 individual four-inch steel conduit tubes penetrating a ten and one-half foot thick concrete wall which incorporated a dense matrix of no. 11 reinforcing rods. This arrangement had been nicknamed the "Bent Tube Scheme" because each tube had to have a "S" shape with double bends to accommodate the 25 degree inclination of the "A" wall. To satisfy this design there had to be at least forty-five different tube configurations, and the tolerances were extremely tight on tube placement and PAR face alignments as the tubes passed through the forest of reinforcing rods. If this original "Bent Tube Scheme" had ultimately been adopted, it would have been extremely time consuming to form and pour and probably could not have been accomplished within the approved construction interval. It was little comfort to know that with better prior planning and coordination, the problem might have been alleviated or avoided altogether. As the Division Historian later assessed it,

> The face difficulty arose because the WSC [BTL] had not approached the design of the face as a systems problem. It appeared that GE designed their part of the system and then

asked that the structure be designed to fit their design and to meet requirements that their design had not properly considered. HND strongly objected to this approach both to SENSM and SENSCOM and as a result a review of alternate schemes was underway [in early 1969]. However, the WSC was well along in design and it would be more difficult to achieve improvements than if a systems approach had been considered from the beginning.[21]

During late February Ammann & Whitney, at the direction of the Division, worked to find an alternative to the "Bent Tube Scheme" which would simplify the construction and ease the tolerance at the interface between the Corps and the WSC. BTL also reviewed the problem from its end, but after three weeks of scrutiny, it reported that the "Bent Tube Scheme" was cheaper than other choices by about $1.5 million per installation. The Corps' best alternative was a variation on the bent tube theme that used about 90 percent straight tubes and 10 percent bent tubes of one pattern only, saving about $750,000 per PAR face. This amount, however, was offset by increased WSC costs. "As a result," the "Historical Summary" notes, "there was an extremely tough construction task on the PAR face. Forming the tubes and rebar (around them) would be exacting and time consuming because of the maze of rebar and embedments."[22] Thus far frustrated in the search for improvement, the Division then proposed the construction of a model research and development test section of the "A" wall at Redstone Arsenal to identify problems and work out techniques.

The projected mock-up would have stood forty-four feet wide, twenty-five feet high, and ten and one-half feet thick. But before construction could begin, a remarkable breakthrough in design was accomplished by a value engineering task force made up of the Systems Engineering Division, Facilities Engineering Division, and Construction Division in conjunction with SAFSCOM, the WSC, BTL, GE, the Atomic Energy Commission, and Ammann & Whitney. This study resulted in a novel design for the "A" wall using only straight tubes and unique floor slots permitting the passage of cable bundles through the "A" wall-floor intersection. Because straight tubes could be easily and uniformly placed through a symmetrical rebar pattern, the "A" wall thickness could be reduced by three and one-half feet while maintaining the desired structural strength. On 29 August 1969, Ammann & Whitney was directed to proceed with redesign for the straight tube penetration system in all future PAR Buildings. This value engineering effort reduced the cost of each PAR Building "A" wall by $921,000 and saved the $225,000 allocated for the wall mock-up which then did not have to be built.[23]

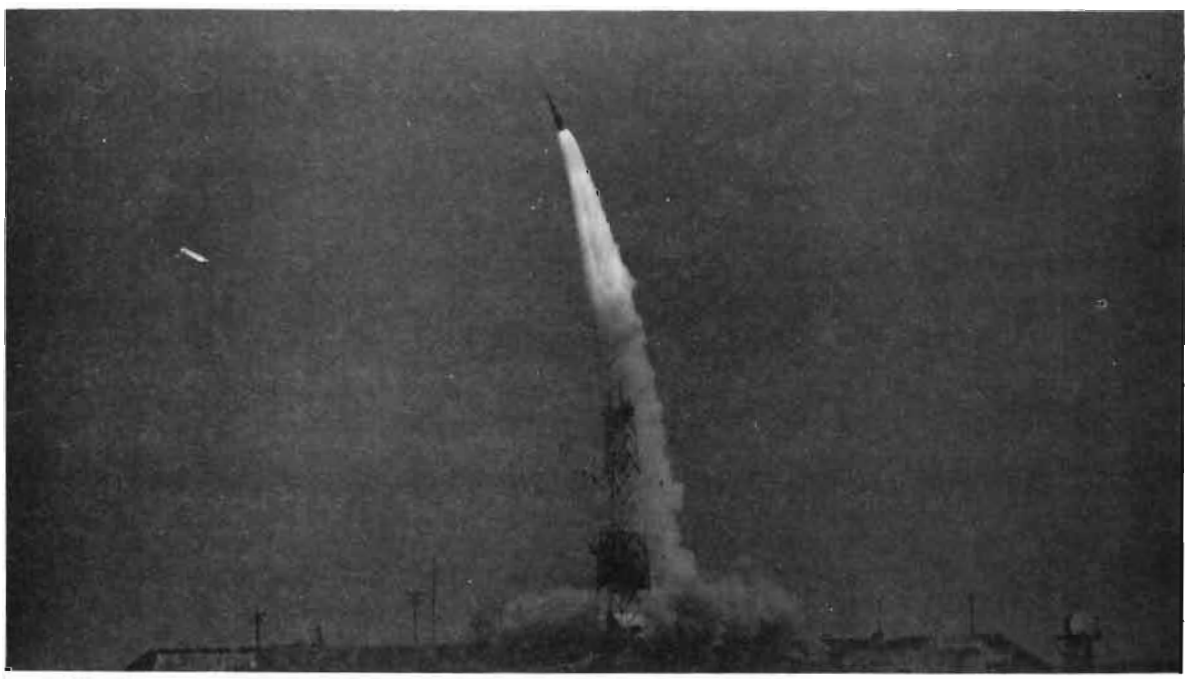
The results of the Presidental review and the inauguration of SAFEGUARD fortunately did not significantly change the PAR Building design. Essentially the SAFEGUARD deployment scheme simply called for relocation of SENTINEL-type facilities at strategic locations away from urban areas and minimized the amount of redesign necessary to accommodate the change. The first two SAFEGUARD sites at Grand Forks and Malmstrom AFB's called for single face PAR's and during the spring and summer of 1969 immediate priority was given to completing the one face design. Thrust towards the two face design was minimized until the need for it was clarified, and as it eventually transpired, the two face design was abandoned altogether.

Unlike the PAR, the SAFEGUARD deployment did mandate some significant design changes in the MSR. Since the Boston MSR had just two active faces, an enlarged turret, the so-called "mini-turret" was now required to accommodate the standard four antenna faces and the equipment for continuous duty operation envisioned under SAFEGUARD. In conjunction with this, hardened cooling towers were discarded and replaced by soft ones with a sealed recirculating heat sink system for emergency use. Additionally, some alterations to the SPARTAN cells were necessary to accept the advance model missiles to be used for SAFEGUARD. These engineering changes were denoted by a change in designation: the former MSR officially became the MSCB, or Missile Site Control Building. Actually, the redesignation never took hold completely and this essay retains use of the term MSR. for the SAFEGUARD building.

Testing of the facilities and weapons system to be employed in SAFEGUARD was little affected by the transition, since these activities were being conducted under previous SENTINEL contracts and were essential to the effectiveness of any future BMD deployment, or even to future research and development. For Huntsville Division, this generally meant a continuation of the same type of shock testing and dynamic analysis performed for SENTINEL facilities and equipment. By 1969, however, it was being discovered that in many cases the testing techniques used earlier were not adequate to realistically simulate the postulated shock motions transmitted through the facilities and tactical support equipment. The test facilities available in 1967 and

1968 were found inadequate in size and capacity to handle the research job, and in 1969, Huntsville initiated efforts to develop both advanced testing techniques and facilities to implement them. Among the results of this effort were sophisticated computer programs for complex waveform synthesis (WAVSYN), hydraulic transient pressure analysis (HYTRAN), and shock isolation system design (ISOL, ISIP), along with installation of the Biaxial Shock Test Machine (BSTM) at the Corps Construction Engineering Research Laboratory (CERL).[24]

SPARTAN TEST FIRING



SPRINT TEST FIRING

Testing of the SAFEGUARD weapon system components outside of the Division also continued during the transition to the new deployment. The last of fourteen SPARTAN developmental test flights was made in December 1969 with all missile and warhead objectives achieved. The first attempt to integrate the SPARTAN with a full system at Meck Island (Mission M1-1) took place on 14 April 1970, but it failed. The rerun of this test on 24 June 1970 proved wholly successful when the SPARTAN completed its intercept under guidance from the Meck Island MSR prototype and its data processing system.

SPRINT testing, too, proceeded during 1969. An extended range SPRINT was flight tested at White Sands Missile Range for the first time on 22 July 1969, and the same type missile with a warhead kit flew in November 1969. Unfortunately, the SPRINT program was struck by a series of premature ignitions and structural failures during October and December 1969 which resulted in an investigation and subsequent modification to the missile's launch tube equipment and first stage. Successful flights were resumed in May and June 1970, and forty-one of the planned forty-two SPRINT developmental flights were accomplished by the end of FY 1970. Until early FY 1971 all of these SPRINT tests were conducted at White Sands. The program then moved to Meck Island to be coordinated with the MSR and data processing equipment there. By this time, the Meck Island MSR had been fully shaken down. In late November 1969, the MSR had acquired and tracked satellite "targets of opportunity," and in December 1969, it successfully acquired and tracked an ICBM launched from Vandenburg AFB, California, using the MSR softwave in an automatic mode.[25]

While termination of SENTINEL projects and adjustments to the new SAFEGUARD orientation went on during 1969, Huntsville Division experienced a transition to greater stability and maturity. Several events and milestones of the year indicated that not only was the Division adjusting to the SAFEGUARD mission, but that it was also leaving behind the temporary and the makeshift characteristic of its infancy. One very evident sign of this was the Division's April 1969 move into modern quarters in a two story brick annex adjoining the new SAFEGUARD headquarters building in Huntsville's Cummings Research Park near Technology Drive. Another sign was the adoption of a permanent unit logo emblematic of the Division's BMD mission. Following a contest open to all Division employees during April and May 1969, Gertrude Desaussure of the Facilities Engineering Division was declared first prize winner and walked away with a $40 award. Her design depicting BDM facilities in the form of the traditional Corps castle launching an ABM can be found on the cover of this **History**.[26] A third sign of

SAFEGUARD SYSTEM COMMAND AND HUNTSVILLE DIVISION HEADQUARTERS BUILDING

HUNTSVILLE DIVISION LOGO

maturation came with the first command inspection led by Maj. Gen. C.H. Dunn on 27 and 28 May 1969, followed a month later by the first annual general inspection of the Division by Lt. Col. Franklin O. Mikle, Inspector General, OCE, during the period 16-20 June. As General Dunn's inspection report later noted, the inspector emerged from these tours with the impression that the Division's personnel remained enthusiastic about their mission despite the uncertainties associated with the SAFEGUARD program. Moreover, the inspectors found "that the dual Engineering Division organizational concept in HND is sound and is working" and that "facilities occupied are excellent and adequate for the current strength."[27]

Huntsville Division's transition into the SAFEGUARD era was accompanied by continued manpower growth, but it was not the kind of extraordinary expansion seen earlier, nor did it necessitate reworking the Division's organization. On 1 May 1969, the Division's strength stood at 354 civilian employees with one position committed and twelve military personnel assigned to the Executive Office (see Appendix I).[28] The inauguration of SAFEGUARD warranted a reappraisal of the Division's manpower needs under Phase I, and while this was being formulated the Division operated under a self- imposed hiring restraint lasting throughout the first half of FY 1970. Under this restraint, the Division's manpower growth was severely restricted in the expectation that peak needs for the SAFEGUARD deployment would almost certainly be less than for the larger SENTINEL program. So it was that by the end of the fourth quarter of FY 1970 (June 1970), the Division's manpower ceiling reached just 376 civilians, 11 officers, and 2 enlisted men, or roughly 10 percent more than at the beginning of SAFEGUARD a year previously. The manpower review conducted for SAFEGUARD indicated that during FY 1971 the Division's needs would rise slightly to a peak in the first quarter of FY 1971, when 385 civilians, 12 officers, and 2 enlisted men would be on the unit's rolls. After this time, a diminution of 30 to 40 per quarter could be expected, with total deactivation

to come in the first quarter of FY 1975. These figures, of course, were for Phase I; a subsequent deployment following any of the Phase II variants would have resulted in other manpower profiles. In effect, then, to carry out the initial SAFEGUARD deployment, Huntsville Division estimated that it would require about 150 fewer employees at peak than for SENTINEL, barring unforeseen changes for Phase II. The Division's Management Analysis Branch did not recommend significant changes in organization during 1969 or 1970 since the internal task assignments for SAFEGUARD were quite similar to those for SENTINEL. A few changes in designation and a slight reorganization of the Facilities Engineering Division were more the result of progress in the Division's mission than the consequence of SAFEGUARD.

As has been seen, until August or September 1969 Congressional debate over SAFEGUARD funds acted as a log jam severely limiting Huntsville Division in the major actions it could take towards executing the SAFEGUARD mission. However, after the landmark Senate vote of 6 August, it became more and more evident that funds necessary for the new program would indeed be forthcoming. The probability of a favorable outcome in the Congress became firmer as the fall wore on, and by November the long-delayed authorizations and appropriations had all been approved and sent to the White House. As a result of this legislation, Huntsville Division was empowered to spend $208.4 million to continue SAFEGUARD facilities design and construction during FY 1971. This total included $16.9 million for design purposes and $191.5 million for construction, mainly for the first two sites at Grand Forks and Malmstrom AFB's. The Division's office operating budget amounted to approximately $6.9 million for FY 1970.

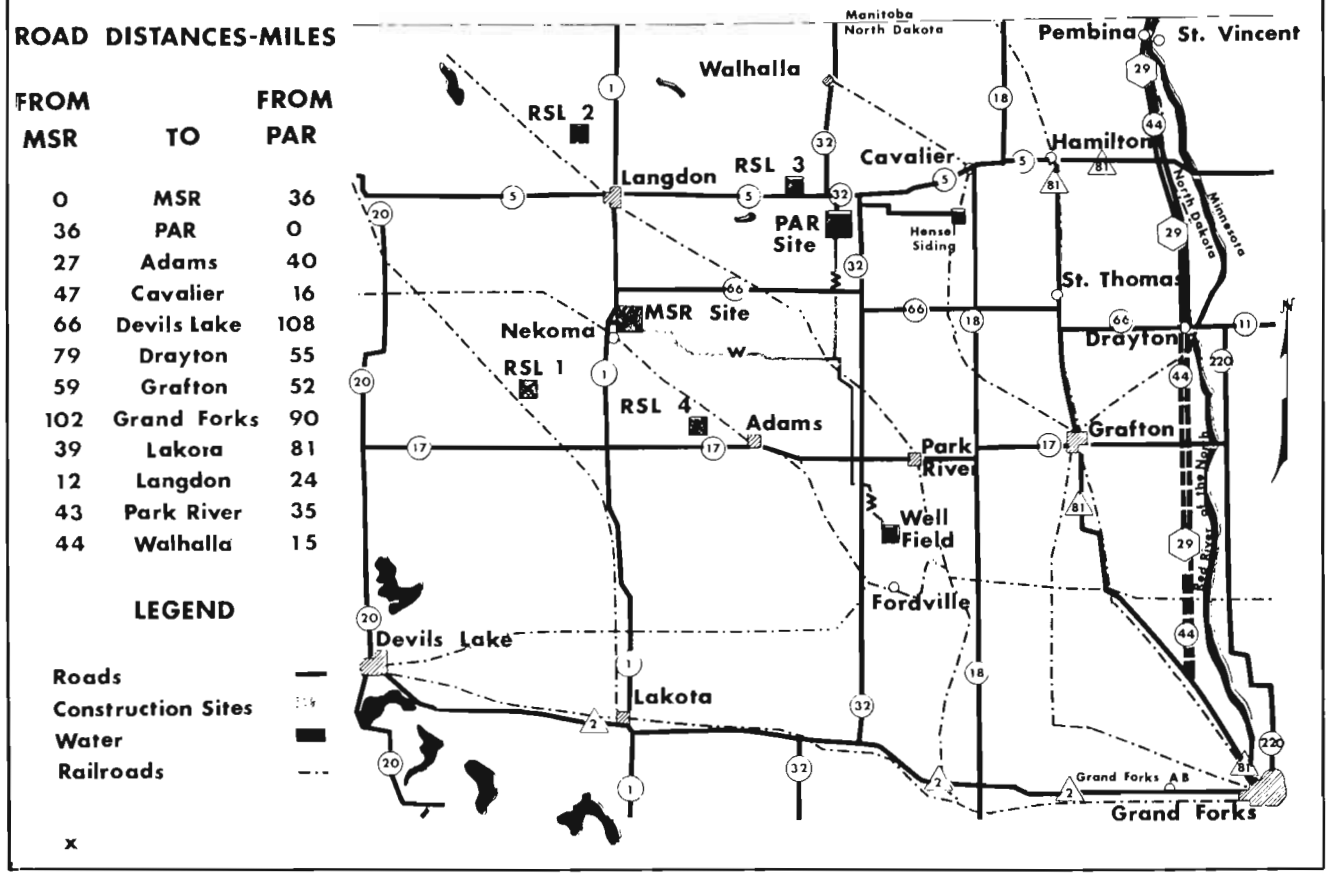
With these funds in hand, it became possible to proceed with the steps leading to construction at the first SAFEGUARD site at Grand Forks AFB, North Dakota. This site had already received high priority under SENTINEL, and it went to the top of the list in the 14 March announcement of the SAFEGUARD deployment. Consequently, the area had been thoroughly reconnoitered and by early fall 1969 preliminary investigations and surveys were nearly completed. Title X property actions were initiated even before the Congressional debate closed, and the real estate proposal was submitted to Congress on 14 October 1969. Omaha District began acquisition of land in January 1970.

The general area chosen for the first SAFEGUARD base was located in the flat wheatlands of northeastern North Dakota close to the Canada-Minnesota border in order to protect nearby Grand Forks AFB, a key MINUTEMAN installation. The 279 acre PAR site was ninety road miles northwest of Grand Forks and twenty-four miles east of the nearest large community of Langdon, while the 433 acre MSR site lay 102 miles northwest of Grand Forks and close to the tiny farming hamlet of Nekoma. About twenty-five air miles separted the PAR from the MSR. The two major installations were complemented by four Remote Launch Sites of thirty-six to forty-five acres each dispersed around the central MSR in a rough circle having a radius of about twenty miles. The entire region had a level black earth topography with a Continental climate and low rainfall perfectly suited to the grain farming that supported the local economy.[29]

As with all SENTINEL and SAFEGUARD installations, planning for the Grand Forks site had to take into account the geographic, topographic, and demographic conditions prevailing in the area. Unlike some other sites, though, several peculiarities of the North Dakota location demanded special attention. One of the most outstanding of these was the question of water supply. The region in which the sites were located had an annual average precipitation of twenty-four inches, sufficient in normal years to sustain the wheat crop together with the sparse human and animal population. Ecologically, then, the land lay in a delicate moisture balance, and the preservation of this balance was naturally of vital concern to local inhabitants who drew their water almost exclusively from wells. Under these conditions, the Army's impact looked a bit threatening: for the Grand Forks site, the Corps intended to introduce a water demand of 1,000 gallons per minute into the area.

Plans for developing an extensive water system yielding the requisite flow without disturbing the regional water table were set in motion even before SAFEGUARD commenced, and a design for such a system was ready by the end of May 1969 in time for that year's construction season. The water was to be drawn from the Fordville aquifer approximately forty-six miles from the MSR site and thirty-five miles from the PAR site. The Fordville aquifer was a curved sand and gravel subsurface formation some three miles wide and nine miles long, having an average water bearing thickness of twenty feet and containing a capacity of 38,000 acre feet (12,383,136,000 gallons) of water. In later hearings on the Corps' proposal, Roger Schmidt of the North Dakota State Water Commission estimated that the Fordville aquifer could be pumped at the rate of 1,000 gallons per minute for twenty-three years without additional

VICINITY MAP - GRAND FORKS SAFEGUARD SITES



recharge.[30] Evidently the Corps' design, which called for ten spaced wells, three booster stations, fifty-eight miles of pipe, and on-site reservoirs, would make no noticeable inroads on the region's below-ground water supply.

The merits of the Corps' plan, however, had to be demonstrated before State authorities as well as local inhabitants in open public hearings before a water permit could be granted by the State. The Congressional debate of 1969 delayed initiation of these proceedings until January 1970, when representatives of the Corps, the U.S. Geological Survey, and the State Water Commission held an open meeting in Fordville to discuss water usage. Here Water Commission members testified to Senator Quentin Burdick and 300 attendees that the Army's needs would have no significant impact on the total water supply, nor would it affect other users of the aquifer. On 9 March 1970, the State of North Dakota issued Conditional Water Permit 1679 to the Corps for use of the Fordville aquifer, with the understanding that,

> if diversions under existing permits to withdraw water from the Fordville aquifer are or will be adversely affected as a result of the exercise of rights created under this permit, the State Engineer reserves right to hold public hearings to assist in determining the rights of the respective users in accordance with State Law.[31]

Permit in hand, the Army awarded a $3,845,000 contract to Zurn Engineers of Upland, California, on 31 March 1970 for construction of the water system. It was completed in about seven months.

In addition to the question of water supply, the Army had to identify other environmental impact factors before breaking ground. Environmental studies indicated no unusual hazard from liquid wastes, solid residues, radio frequency interference, noise, or radiation, but a potential problem did arise in

the case of air pollution from the facilities' diesel powerplants. Early in December 1969, the Office of Counsel at Huntsville Division drafted a legal study of the implications of building the Grand Forks site with reference to its conformity with air pollution regulations. In the North Dakota situation, State pollution laws presented a minor obstacle: contemporary computations indicated that in the worst possible case contaminants would exceed the State maximum allowable standard 8 percent of the time over a plume area roughly two miles downwind of the Government reservation. The report furnished other details of the State law and relevant factors of interpretation, then observed that the Corps as a federal agency did not have to voluntarily comply with a State law. The Corps was, however, subject to federal law, particularly to the "Clean Air Act" of 1963 and Executive Order No. 11282 mandating compliance by federal agencies. Here again, however, Counsel reported "an exception is given in extraordinary cases of public interest, and the Secretary of HEW may exempt any Federal agency."[32] Finally, it was suggested that the Corps first determine with greater precision the possibility and potential of the problem of diesel exhaust fumes, followed by determination of possible remedies and cost. Then, the brief concluded, "if full compliance is not feasible, technical advice and/or an exemption permit should be obtained by the Secretary of HEW."[33] On 23 December, the SAFSM was apprised of the problem, and the assistance of other Government agencies was solicited. Six months later, on 24 June 1970, no better solution had been found and Cooper-Bessemer, makers of the offending engines, was contracted to come up with a method of suppressing the NOX emissions from their product.[34]

In addition to the impact on the environment, the Army also had to assess and assuage the effects of construction on the human community. Once again the situation in North Dakota was somewhat out of the ordinary. The population of the area was very thin; Langdon, the county seat of Cavalier County and the largest community in the immediate vicinity of the sites, had only 2,151 inhabitants in 1970 and other villages in the area were even smaller. The introduction of a thousand or more construction workers and several hundred service personnel later would present a substantial intrusion on the locality's schools, shopping outlets, recreational facilities, utilities capacity, public service authorities, and transportation net. Forecasting this impact, in May 1969, Huntsville Division organized a planning group to work with SAFSCOM on a full time basis to develop practical solutions to the community impact problem. Beginning in November 1969, a Community Impact Team from Omaha District studied the resources of all communities within fifty miles radius of Langdon and all settlements over 10,000 within 100 miles. The report was published in April 1970.[35]

A few figures selected from the community impact report will illustrate the magnitude of the problem. The reconnaissance team estimated that the temporary population increase due to SAFEGUARD would peak at 8,100 in the fall of 1971. This influx would mingle with an established population of about 25,000 in the affected circular area to generate a rise of one-third in two years' time. The permanent population increase would be less, about 2,200. School enrollments would be increased by 1,505 during 1970-1971 to a peak of 2,505 in 1973-1974, and this increase would demand additional plant facilities for 950 students by 1973-1974. Public utilities were deemed "adequate," except for the Langdon sewer system; three additional police officers and four permanent fireman would have to be added to existing forces in the area surveyed.

It is important to note that even though the Department of the Army was responsible for creating the impact problem, it could not legally give relief in the form of funds. Much federal money was available for community impact relief, but it came from several federal agencies outside the military and was granted only after application from local authorities. Thus, Public Law 874 of the 81st Congress provided for federal assistance to local educational systems affected by military presence; Langdon, which needed a new sewer system, could apply through Public Law 660, 84th Congress; and Public Law 90-351 provided matching grants to assist states and local governments in law enforcement. After protests in North Dakota and Montana that these funds were inadequate and/or too slow in coming, Congress acted through Public Law 91-511, Section 610, authorizing military construction for FY 1971 to provide additional assistance to local communities near SAFEGUARD construction in North Dakota and Montana. The SAFEGUARD System Manager was made responsible for overall administration.[36]

A large part of SAFEGUARD's impact on North Dakota communities revolved about heavy demands on the area's transportation network, especially during the actual period of construction. The region between Grand Forks and Langdon was well supplied with railroads, but the line nearest the PAR site was thirteen miles away as the crow flies to Hensel, and this crossing had no delivery siding. Additionally, the

accidents of geography meant that existing roads linking Hensel with the PAR and MSR sites were two lane unsurfaced county section line roads intended solely for light farm traffic, not for heavy construction trucks weighing tens of tons. Nevertheless, it was known from reconnaissance of the area that local arteries would bear a heavy burden of construction traffic:

> At the outset of the Grand Forks SAFEGUARD Project, it was a well-known fact that no suitable aggregate for concrete existed in North Dakota. This had been determined by geological parties from the Missouri River Division of the Corps. Further, these parties found suitable aggregate could be obtained from Minnesota. Consequently, all such materials had to be shipped in by rail. The Contractor received as many as forty-two hoppers a day on many days.[37]

The destructive pounding of such traffic was compounded by the harsh cold of the region which further eroded damaged surfaces by splitting and frost heave.

Planning to remedy this situation began in April and May 1969, but action was delayed until after the Congressional Debate was nearly concluded. In particular, a rail spur siding had to be constructed at Hensel and thirteen miles of access roads bolstered between the siding and the sites. Time did not permit formalization of a contract for the rail siding before the start of construction in the spring of 1970, so on 19 September 1969 OCE authorized a letter contract with the Great Northern Railroad to be administered by the Omaha District. The letter contract was issued on 19 October. The estimated cost was $150,000. Work on the siding began late in the year and was completed the next spring.[38]

Likewise, during the summer of 1969 the North Dakota Road Department prepared designs for light haul road improvements, and on 4 November the Department was able to contract for the work. This was handled by Military Traffic Management and Terminal Service with State road officials under authority of the "Fulbright Amendment" (see Chapter I). Despite the winter season, the improvements were completed during December. As it turned out, the Army underestimated the degree of strengthening and improvement needed, and the Hensel haul road gave constant trouble until it was hard surfaced in the spring of 1971.[39]

Three final human concerns related to Grand Forks construction lay in the areas of housing, labor relations, and the hiring of minorities for construction work. Local housing for transients was quite limited in and around Langdon, so most of the construction workforce commuted to the jobsite, many from as far away as Grand Forks. Others were accommodated in the traditional hard hat's dwelling, the mobile home. Soon after the main construction contract was awarded in March 1970, the contractor purchased a tract of land near Langdon and developed a trailer park for supervisory personnel and their families. By June 1970 some 100 trailers were lodged in the contractor's trailer park.[40]

The same critical housing shortage faced the 300-odd Government employees from both the Corps and SAFSCOM that were assigned to a region in North Dakota without sufficient housing accomodations for all. As the Huntsville Division's "History of the Office of Counsel" dryly records, "No regulations covered this situation, and the solution proved to be long and complicated with many differences of opinion."[41] Originally, a 1969 plan was devised to issue a contract for 180 mobile homes in two mobile home parks to be owned and operated by the housing contractor and located at Langdon and possibly Cavalier. Unfortunately, this scheme bogged down in legal questions of whether it could be done through Military Construction Appropriations without the specific approval of Congress. Finally, on 16 January 1970 the Corps received tentative authority to enter a contract, and the Omaha District was delegated responsibility to issue the IFB and administer the contract. The District advertised for furnishing temporary mobile homes, constructing a park, and maintenance, but all the bids received on 31 Marsh 1970 far exceeded Government expectations. Accordingly, the IFB was cancelled and an award was made through RFP negotiations with Cavalier Estates, Inc., on 2 July 1970 for the first increment of thirty mobile homes. Each mobile home cost $7,000, but the total acceptable offer was $419,643. A second increment of eighty-five mobile homes was awarded to Western States Construction Company, Inc., on 8 October 1970 for the total amount of $1,098,300. The contract amounts were in addition to the rents to be collected by the contractor, of which 90 percent was guaranteed. The "Cavalier Estates," as the parks came to be known, alleviated but did not wholly solve Government employees' housing worries. Satisfactory housing, especially for those with dependents, remained a pressing concern of transfers to Grand Forks until the work was in its second or third year.[42]

The low population density of North Dakota ensured that many workers would have to be attracted

from, outside sources, while the remoteness and severe climatic conditions tended to promote unusually high wage rates. Furthermore, limited housing on or near the work place required many workers to commute over long distances, and this posed the question of per diem allowances for such travel. All of these factors were of great interest to local labor unions, as well as to their national organizations which regarded issues at Grand Forks as setting the tone for future BMD work across the nation. An additional element of concern to all parties was the influence of inflation which promised to play an important role over three years of construction.

A foundation for good labor relations at Grand Forks began with the Corps working through the Grand Forks AFB Missile Sites Labor Relations Committee, an organization which replaced the President's Missile Sites Labor Committee of the ICBM era. On 6 November 1969, Huntsville personnel conducted a project briefing before a regularly scheduled meeting of the Committee in Fargo, North Dakota, for representatives of the Government, Air Force, labor unions, and contractors. This initial briefing was followed by other conferences with the Committee and with the North Dakota Chapter, Associated General Contractors of America, Labor Committee in Fargo on 7 and 8 January. At the Associated Contractors meeting on 7 January, Huntsville Division's Labor Relations Officer, Stephen V. Rohr, explained the advantages of a comprehensive project labor agreement, an agreement thought to be in the best interests of the Government and contractors alike. Next day, 8 January, Rohr and Federal Mediation and Conciliation Service representative Gordon Preble again met with the Grand Forks AFB Missile Site Labor Committee. In addition to Rohr and Preble, about fifteen local labor representatives appeared. Several questions such as "When would contracts be let?" and others concerning a Navy project at Lamoure, North Dakota, were submitted by local labor attendees. During this visit, Rohr collected copies of previous local labor agreements, together with the approximate number of members, location, and current wage rates, as well as rates prevailing in Minneapolis and St. Paul, urban areas against which the Corps would be competing. These January meetings produced substantial data, along with the unsettling revelation that inflation might well escalate wage rates by more than 40 percent during the life of the Grand Forks project.

As a result of this inflationary prospect, the Huntsville Division Labor Relations staff, working through the auspices of the North Dakota Chapter of the Associated General Contractors, prodded contractors interested in bidding on the Grand Forks project to negotiate a blanket long-range project agreement with construction trades unions for all North Dakota BMD activity. Discussions for such a pact were conducted in Fargo during February and March 1970 between labor and the management of three interested joint ventures, together with Government and Corps observers. The final "Project Agreement" provided a fixed wage and fringe benefit schedule over the entire three year construction period. This provision eliminated the necessity for contractors to include contingencies in their bids to cover anticipated wage escalation and had a tremendous stabilizing effect on labor relations for the Grand Forks project. Other issues sensitive to labor, such as travel and subsistence, health and safety, grievance settlement, and dues check-off, were also resolved in the "Agreement."[43]

One important requirement for labor arrangements in North Dakota emerged only after Invitations for Bids were mailed out on 23 January. In that Invitation, Huntsville Division included what heretofore had been considered a routine Equal Employment Opportunity Clause. On 13 February, however, the Department of Defense notified Huntsville Division that certain specific goals for the employment of minorities should henceforth be incorporated in affirmative action plans submitted by federal contractors as part of compliance to Title VII of the 1964 Civil Rights Act and subsequent Executive Orders 10925, 11114, and 11246. This change of policy was, in fact, the result of an Office of Federal Contract Compliance effort to make SAFEGUARD a pilot program for extending the limited "Philadelphia Plan" of 1969 into federal contracts on a nationwide basis.

The need to implement specific equal employment opportunity goals was outlined to potential SAFEGUARD contractors and subcontractors at a pre-bid conference held at Huntsville on 26 February. Not long after, on 2 March, Huntsville Division formally issued Para. 14 of Amendment 005A to "Instructions to Bidders" in the Grand Forks IFB that stated:

> The bidder shall deliver to the Contracting Office, Huntsville Division, Corps of Engineers, on or before 20 March 1970, an Affirmative Action Program which will express the bidder's good faith efforts to carry out his affirmative action obligations in equal employment opportunity as required by

WAGE RATES

GRAND FORKS AREA

TRADE	CURRENT RATES HOURLY	NATIONAL AVERAGE OCT 1960 HOURLY	1 JUNE 1970 HOURLY	1 JUNE 1971 HOURLY	1 JUNE 1972 HOURLY	OVER 1973 HOURLY	1 JUNE TIME HOURLY	TRAVEL AND/OR SUBSISTENCE DAILY
I. SIGNED AGREEMENT								
Laborer	$3.65	4.29	4.40	5.10	5.55	6.00	1 1/2	8.00
Carpenter	4.55	5.92	5.60	6.30	6.90	7.50	1 1/2	8.00
Iron Worker	5.95	6.70	7.05	7.90	8.65	9.15	2	10.00
Cement Finisher	4.75	5.00	5.80	6.50	7.10	7.70	1 1/2	8.00
Oprtng Engr	4.62	7.40	5.42	6.17	6.90	7.52	1 1/2	8.00
Truck Driver	3.65	4.40	4.65	5.15	5.65	6.20	1 1/2	8.00
II. PROJECTED AGREEMENTS								
Electrician	6.15	6.26	7.00	7.75	8.50	9.25	2	
Plumber/Fitter	5.37	6.83	6.40	7.25	8.15	9.00	1 1/2	10.00

NOTES: 1. Projected figures include fringe benefits: $.55 for Iron Workers and $.25 for Operating Engineers

2. Current travel and subsistance allowance ranges from $4 to $10.

General Provision 21 and Executive Order 11246, and which has been determined to be acceptable by the Contracts Compliance Office, Defense Contracts Administration Services.[44]

It was unofficially understood by all parties that this unspecified "good faith" effort should amount to about six to ten percent of the work force, but potential contractors for Grand Forks believed these figures to be excessive in view of the fact that North Dakota's population included only 2 percent minorities, most of which were untrained Indians isolated on scattered reservations. In Cavalier County itself there were no non-whites, and in adjoining Grand Forks, Trail, and Stelle, counties there were only 168 minority residents of all kinds. Accordingly, early in March the Associated General Contractors protested the Corps' amendment on the grounds that the U.S. Comptroller General had previously found ambiguities like the "good faith" clause in bidding documents illegal in his decision 47 CG 666. Despite these feelings, and a generally gloomy outlook for immediate fulfillment, three joint ventures interested in Grand Forks submitted EEO Affirmative Action Programs that were found acceptable by the Defense Contract Administration Services in mid-March. Two significant features of these Affirmtive Action Programs were the "good faith" goals of 6 to 10 percent minorities employment overall and satisfactory weekly reporting procedures on progress made towards these goals. Not surprisingly, the ultimate fulfillment of even 6 percent minority employment was later found difficult, and affirmative action goals were later revised to a more flexible scheme of 6 to 10 percent of minority labor hours put in on the job. Compliance personnel in Defense Contract Administration Services later found that these goals were generally met by all contractors on the project.[45]

In the meanwhile, having set the necessary preliminaries in motion for Grand Forks construction, only preparation of the bid package and its award remained before ground-breaking could take place. Early in September 1969, recommendations were made to the SAFEGUARD Systems Manager and to OCE concerning the desirability of combining the technical facilities at Grand Forks--the PAR and the MSR--into a single contract bid package to mitigate the impact of multiple major contracts on limited community resources, as well as to minimize the prospect of intensive competition for skilled labor in the area. The less demanding, smaller scale RLS's were to be split off from the main package, as were the Non-technical Support Facilities. The recommendation was accepted, and on 23 October Advanced Notices of Invitations for Bids for the North Dakota SAFEGUARD technical facilities were put into the mail.

The contractual policies followed for this and other SAFEGUARD sites remained very much the same as under SENTINEL. As noted above in Chapter I, standardization and procurement of Government Furnished Property were confirmed early in the spring of 1969, and the same continuity was maintained in contractor prequalification. Contractors who considered themselves candidates for any job had to prequalify their firms with Huntsville Division several weeks before Invitations for Bids were sent out. As earlier, this policy of prequalification aided the Corps in sizing up the capabilities and performance potential of contractors before bidding was opened. If this had not been done, it was possible that some bids might have been submitted and awards won by firms without the resources to fulfill the rigid scheduling and precise techniques required to complete the facilities. The delay and cost penalties so incurred would have been intolerable for a vital national defense program.

Prequalification for Grand Forks in early December and January produced a total of fifty-six applications, of which thirty-seven were accepted. Of these thirty-seven prequalified applications, ten were from prime contractors, eleven from joint venture sponsors, and sixteen from joint venture members. The relatively limited number of approved contractors came from all over the nation, indicating the small number of firms capable of taking on a construction project as large and as sophisticated as Grand Forks under North Dakota weather conditions. Moreover, the number of contractors actually interested in preparing and submitting bids for such a challenge proved to be even less. By the time bids were opened in March, only three joint ventures, each a consortium of several large firms, came forward with offers to do the job.

A few general figures will illustrate the magnitude of the Grand Forks project. In the PAR and MSR Buildings and their powerplants alone, over 238,000 cubic yards of concrete and over 27,500 tons of reinforcing steel had to be emplaced in the main buildings. This included enough cement to lay a normal two lane concrete road twenty-four feet wide, eight inches deep, and thirty-two miles long. Enough earthwork would have to precede this to build up a mound three stories high and one-quarter mile on each side; enough reinforcing steel was required to erect a normal four story building covering two acres of land,

or almost 300 feet on each side. Without including the radar or weaponry, enough wire was needed to stretch 2,273 miles, or about the distance from Huntsville to San Francisco. At the peak of construction during the summer and fall of 1972, about 3,200 persons would be employed; this included over 2,900 hard hat artisans, craftsmen, operators, and laborers, together with 300 Corps, SACom, and WSC employees.

The scheduling was impressive, too. The PAR Building was to be completely roofed in by September 1971, and it had to be essentially ready for the WSC in August 1972 (a deadline called the Benficial Occupany Date, or BOD). The MSR Buildingwas to be roofed in by October 1971 and occupied by the WSC a few months later. Thus, a total of about two and one-half to three years was allowed for the major portion of the construction, some of which would be under severe climatic conditions. The immediate goals for the first construction season ending in December 1970 were to have the first and second levels of the PAR and MSR Building shells closed in to permit more or less normal interior work during cold winter conditions outside.[46]

The Area Engineer and his staff at the job site bore the heaviest responsibility in seeing that this construction schedule was met. On 6 November 1969 Col. Roy Beatty, previously Area Engineer for the Boston SENTINEL project, was named Area Engineer for Grand Forks. Col. Beatty did not join the job until after ground-breaking on 6 April 1970, but a temporary area office was opened in Langdon, North Dakota, on the day after his appointment. This area office at first occupied one room in the Langdon Masonic Temple but later expanded to take in all of the basement and the entire first floor. The first Civil Service examinations for staffing the office were administered at the Post Office in Devil's Lake, North Dakota, on 8 January, and permanent clerical personnel arrived soon thereafter. The office transferred its operations to the PAR site when an office building was completed there during the summer of 1970.[47]

Contracting for the Grand Forks job moved into high gear during early January 1970 with the preparation of the largest bid package ever printed by the Corps of Engineers in its 195 year history. The total printing job amounted to 2,626,200 pages of architectural drawings and 4,340,000 pages of specifications, enough paper to make a single column reaching 2,500 feet, or twice the height of the Empire State Building. If assembled in one place, the bulk would have amounted to sixty-five tons. Individual sets of plans offered to contractors were roughly the size of an office desk and weighed 200 pounds. Each set cost bidders $40, with reductions for subsequent sets. The Procurement and Supply Division distributed 172 such full sets of plans and specifications, together with ninety-six sets of specifications and 147 volumes of plans.[48]

From the inception, Huntsville Division required considerable assistance in preparing this package to meet the 23 January issuance deadline. Six Corps of Engineers districts, Redstone Arsenal, and commerical printers shared certain assigned printing tasks. Commonality throughout was ensured by using microfilm masters on which the original drawings were reduced thirty times, sent to distant points for printing, then enlarged fifteen times to make a positive offset printing plate of 15 x 21 inches. Except for certain drawings mailed by Los Angeles District, final copies were assembled in Huntsville and prepared for mailing in a large warehouse on Redstone Arsenal, where an assembly line boxed, wrapped, sacked, and sorted the sets according to destination.[49]

To deal with the deluge of questions sure to pour in from bidders on a project of this size, Huntsville Division established a "hotline" to an Inquiry Informational Center in Facilities Engineering Division. Further, unresolved questions were fielded in Huntsville on 26 February 1970, when the Division sponsored a pre-bid conference at the Sheraton Motor Inn. Over 250 conferees representing prime contractors, subcontractors, suppliers, associated construction industries, and Governmental agencies heard Col. Robert W. McBride describe the SAFEGUARD System and related construction factors. Written inquiries submitted beforehand were answered, and the entire conference was taped and transcripts provided conferees.[50]

Bids were opened at St. Paul Municipal Auditorium, St. Paul, Minnesota, at 11:00 AM on 26 March 1970. Of three bids received, a joint venture comprised of Morrison-Knudsen, Inc., Peter Kiewit Sons' Co., Fischbach & Moore, Inc., and C.H. Leavell & Co. submitted the low bid of $137,858,850. The Government estimate had been $126,119,014, but the low bid of Morrison-Knudsen & Associates was formally accepted on 31 March 1970 as the lowest competitive bid. This award constituted the largest single construction contract awarded by the U.S. Army Corps of Engineers up until that time. Morrison-Knudsen & Associates received notification to proceed at the beginning of April, and with this notice the actual construction of SAFEGUARD facilities got underway. The transition to

SAFEGUARD was complete, one year and two weeks after the close of the Presidential review on 14 March 1969.[51]

A $137,858,850 contract for construction of the Nation's first SAFEGUARD ballistic missile defense system facilities being installed in the area of Grand Forks, N.D. was signed by Colonel Robert W. McBride, Huntsville Division Contracting Officer. Looking on were Brigadier General R.P. Young, Huntsville Division, Engineer; Joe Leas, Executive Vice President, C.H. Leavell & Co., El Paso, Texas; E.M. Armstrong, Vice President for Business Development, Morrison-Knudsen Co., Inc., Boise, Idaho; Lee Rowe, Vice President, Peter Kiewit Sons' Co., Omaha, Nebraska; S.E. Davidson, Regional Vice President, Fischback and Moore, Inc., Los Angeles, California; and Colonel Bates C. Burnell, Huntsville Deputy Division Engineer.

APRIL 1, 1970 -- Final review of bid documents was made by Emil Vuch, Chief Legal Counsel of the Huntsville Division, prior to contract award to Morrison-Knudsen Company and Associates.

CHAPTER II FOOTNOTES

[1]In 1969 Dr. Herbert F. York was Professor of Physics at the University of California at San Diego and a member of the general advisory committee of the U.S. Arms Control and Disarmament Agency. He had formerly been Chancellor of U. of C. San Diego, director of defense research and engineering in the office of the Secretary of Defense (1958-61), and twice a member of the President's Science Advisory Committee. Dr. Jerome B. Wiesner was in 1969 Provost of Massachusetts Institute of Technology, having served on the faculties of several engineering schools and as a member of the staff of Los Alamos Science Laboratory. Dr. George W. Rathjens was director of the Weapons Systems Evaluation Division of the Institute for Defense Analysis at M.I.T. in 1969. Rathjens had formerly been chief scientist in the Advanced Research Projects Agency of the Department of Defense (1961-62), and from 1962-65 he held various posts with the U.S. Arms Control and Disarmament Agency. Dr. Hans A. Bethe was serving on the physics faculty of Cornell University in 1969. He had been at the university since 1935. In 1968, he won a Nobel Prize in physics for contributions to the theory of nuclear reactions. In 1969, Richard L. Garwin was director of applied research at the Thomas J. Watson Research Center of the International Business Machines Corporation.

[2]These three articles constitute a significant part of the literature on the BMD question. See Richard L. Garwin and Hans A. Bethe, "Anti-Ballistic Missile Systems," **Scientific American**, CCXVII, No. 3 (March, 1968), pp. 21-31; George W. Rathjens, "The Dynamics of the Arms Race," **Scientific American,** CCXX, No. 4 (April, 1969), pp. 15-25; and Herbert F. York, "Military Technology and National Security," **Scientific American,** CCXXI, No. 2 (August, 1969), pp. 17-29.

[3]**Boston Globe**, 30 January 1969, p. 1.

[4]Halt of SENTINEL is Traced to a Memorandum," **New York Times**, 9 February 1969, p. 1.

[5]**IBID.**; Senator Edward Kennedy to Secretary of Defense Melvin Laird, letter of 31 January 1969 reprinted in the **Congressional Record,** 4 February 1969, p. 2500.

[6]I have used the text of the Presidential news conference as it was reproduced in the USAEDH "Information Bulletin," II, No. 1 (7 April 1969), 1-7, and in the USEDH "Historical Summary FY 1969," II, Documents, 98-103. The behind-the scenes story of how President Nixon made the decision announced on 14 March is described by reporter Robert B. Semple in the **New York Times** article "Nixon Staff Had Central Role in Missile Decision," 19 March 1969, p. 22. According to Semple, the President's decision was highly internalized, made through "a controlled but intense dialogue limited to his own staff and principal foreign policy advisers." Nixon did not solicit opponents or advocates of the system outside the White House, did not rely principally on scientific advisers, and did not make friendly contacts in universities as President Kennedy liked to do. The President's decision was largely shaped by considerations of foreign policy, in particular relations with the Soviets, rather than domestic political considerations. Apparently, Semple reported, there were two Presidential decisions. In making the first decision, Nixon relied on the opinions of his chief foreign policy adviser Henry Kissinger and Deputy Secretary of Defense David Packard. In February, Nixon received from Kissinger a 40 page briefing book containing arguments pro and con for SENTINEL and from Packard Defense Department presentations on four options. One of these was a "thick" SENTINEL, preferred by the JSC; the second, a "thin SENTINEL reduced to about 15 urban sites; the third, a modified SENTINEL System called Plan 1-69, shifting deployment from cities to MINUTEMAN sites; and fourth, no system at all. Sometimes over the weekend of 7-8 March while the President was at Key Biscayne, Florida, he decided to move ahead with Plan 1-69, a SENTINEL System modified to protect the Nation's deterrent forces. The second decision, amplifying and implementing the first, was taken in Washington after Nixon's return to the White House. Upon returning to Washington, the President again conferred with Kissinger, Packard, and Dr. John Foster, head of defense engineering and research, to decide on implementing Plan 1-69. Again, there were four choices, of which the President selected the fourth. This was a phased deployment with the great advantage of flexibility, especially worthwhile in view of the approaching arms talks with the USSR.

[7]U.S. Department of Defense News Release No. 190-69, "Statement by Deputy Secretary of Defense David Packard, March 14, 1969"; **New York Times,** 15 March 1969; Adams, Ballistic Missile Defense, pp. 198-200.

[8]Teletype message, DOD to USAEDH, 24 March 1969, "Redesignation of SENTINEL BMD System to SAFEGUARD." For unknown reasons this message does not appear in the Division's "Historical Summary FY 1969," II, Documents, nor is it mentioned in Vol. I, Narrative, at the appropriate period. I have utilized instead a copy found in USAEDH-OC, "History of the Office of Counsel," Vol. I, Ex. 20.

[9]"The Useless 'Safeguard,'" editorial in the **New York Times,** 15 March 1969.

[10]Adams, **Ballistic Missile Defense,** p. 247. Adams writes, "Despite all the seriousness attached to the 'Great BMD Debate' in the scientific/academic community and the Congress, as well as in the Executive Branch whose BMD proposal hung in the balance, the author believes the BMD was only symbolic, except to the long-time opponents of deployment, of a mood then prevalent in the country. That mood was one of despair and frustration with the military, its influence, military spending overruns and costs, the war in Vietnam, the belief that U.S priorities were mistakenly reversed and dislocated, inflation, and the arms race. Missile defense was something to grasp. If it could be defeated, then it was a start to altering the mood, the milieu, and the priorities."

[11]The most important of these Congressional hearings in document form is U.S. Senate, Hearings Before the Subcommittee on International Organization and Disarmament Affairs of the Committee on Foreign Relations, **Strategic and Foreign Policy**

Implications of ABM Systems, Pts. I, II, and III, 91st Cong., lst Session, 1969. These three green paperback volumes contain most of the relevant arguments pro and con the ABM presented in the 1969 Congressional forum.

[12]Adams, **Ballistic Missile Defense,** pp. 215-221.

[13]Ibid., pp. 220-221.

[14]USAEDH-PAO, "Information Bulletin," II, No. 5 (12 Aug. 1969), p.1.

[15]USAEDH-PAO, "Information Bulletin," II, No. 6 (5 Sept. 1969), p.1.

[16]USAEDH-PAO, "Historical Summary FY 1969," II Documents, pp. 121-122.

[17]OCE, Command Inspection Report, U.S. Army Engineer Division, Huntsville, 28-29 May 1969, pp. 2, 5.

[18]The Boston Phase II contract with Morrison-Knudsen was settled on 26 October 1970 for $251,242.92. The "Historical Summary" does not give the final negotiated settlement amount of the George Brox, Inc., contract.

[19]**Boston Sunday Globe,** 9 July 1972, p. 46-A.

[20]USAEDH-OC, "History of the Office of Counsel," Supp. 2 (Apr. 1969 - Feb. 1970), p. 18.

[21]USAEDH-PAO, "Historical Summary FY 1969," I, Narrative, pp.88-89.

[22]Ibid., p. 93.

[23]USAEDH-PAO, "Information Bulletin," IV, No. 6 (2 April 1971), p. 2.

[24]USAEDH-PAO, "Information Bulletin," VII, No. 4 (12 Apr. 1974), pp. 1-2.

[25]BMDSCOM, "Summary of the SAFEGUARD Program FY 1970," pp. 2-3.

[26]USAEDH-PAO, "Information Bulletin," II, No. 2 (9 May 1969), p. 3, and II, No. 4 (14 July 1969), p. 1.

[27]OCE, Command Inspection Report, U.S. Army Engineer Division, Huntsville, 28-29 May 1969, p. 2.

[28]The "Historical Summary" indicates that on 1 May 1969 strength of the Executive Office stood at twenty-two. I have concluded that this is a miss-print. USAEDH-PAO, "Historical Summary FY 1969," I, Narrative, p. 99.

[29]USAEDH-PAO, "SAFEGUARD: A Step Towards Peace," p. 1.

[30]USAEDH-PAO, "Information Bulletin," III, No. 2 (30 Jan. 1970), pp. 3-4.

[31]USAEDH-PAO, "Historical Summary FY 1970," II, Documents, p. 83, reproduces the text of the North Dakota Water Permit.

[32]USAEDH-PAO, "Historical Summary FY 1070," II, Documents, pp. 77-79, reproduces the text of the Office of Counsel brief on air pollution.

[33]USAEDH-PAO, "Historical Summary FY 1970," II, Documents, p. 79.

[34]This was Contract DACA87-70-C-0019 in the amount of $31,000. USAEDH-PAO, "Historical Summary FY 1970," I, Narrative, p. 21.

[35]U.S. Army Engr. Dist. OMAHA, "U.S. Army SAFEGUARD System Command Community Impact Report Grand Forks Deployment Area," April 1970.

[36]Ibid., passim; USAEDH-OC, "History of the Office of Counsel," Supp. 4 (Oct. 1970. 1971), p. 20.

[37] USAEDH-GF, "History of the Grand Forks Office," FY1970, p. 7.

[38]USAEDH-OC, "History of the Office of Counsel," Supp. 2 (Apr. 1969 - Feb. 1970), p. 15.

[39]Ibid.

[40]USAEDH-GF, "History of the Grand Forks Office," FY 1970, p. 15; USAEDH-PAO, "Historical Summary FY 1970, "I, Narrative, p. 30.

[41]USAEDH-OC, "History of the Office of Counsel," Supp. 2 (Apr. 1969 - Feb. 1970), p. 15.

[42]Ibid., pp. 15-17, and Vol. I, Ex. 79, Memoranda 9 May - 13 February 1970, "Concepts and Legality of Government Furnished Temporary Housing."

[43]USAEDH-PAO, "Historical Summary FY 1970," II, Documents, pp. 61-69, reproduces the trip reports, agenda, and roster of attendees at the preparatory labor meetings in North Dakota. I have also referred to the trip report filed on 5 March 1970 by Ralph J. Thayer, Labor Relations Representative, USAEDH, after a February 16-17 visit to North Dakota. This report is not in the "Historical Summary" or in the "History of the Office of Counsel," but it can be found in USAEDH Office of Counsel file, "Labor Relations--North Dakota." Additional information concerning the formulation of a project agreement for Grand Forks was generously provided by

conversation with Stephen V. Rohr, then Labor Relations Officer for the Huntsville Division, on 5 January 1978.

[44]Amendment 005A to Invitation for Bids DACA87-70-B-0001, issued 23 January 1970. This IFB was modified by a total of ten amendments dated 9 Feb., 12 Feb., 21 Feb., 27 FEb., 2 Mar., 7 Mar., 13 Mar., 16 Mar., 19 Mar., and 20 Mar. 1970.

[45]USAEDH-OC, "History of the Office of Counsel," Supp. 3 (Feb. 1970 - Oct. 1970), 41-42; Memorandum for Record: "Summary of Conference to Plan EEO Procedures for the Grand Forks Construction. 26 February 1970," in USAEDH-OC, "History of the Office of Counsel," Vol. III, Ex. 172; Topic Outline for Division Engineers Conference on 29-30 April, 1 May 1970: "Affirmtive Action Program Required of Construction Bidders to Carry Out Equal Employment Opportunity," in USAEDH-OC, "History of the Office of Counsel," Vol. III, Ex.172; USAEDH-PAO, "Historical Summary FY 1970," II, Documents, p. 80. Additional information concerning the problems of minority employment in Grand Forks was generously provided by Stephen V. Rohr, Huntsville's Labor Relations Officer, by telephone conversation on 5 January 1978, and by Emil Vuch, the Division's Chief Counsel, in several personal conversations with the author.

[46]USAEDH-PAO, "Information Bulletin," III, No. 6 (27 Mar. 1970), p. 3; III, No. 9 (8 May 1970), pp. 1-4; VI, No. 11 (14 Dec. 1973), p. 2; VII, No. 3 (17 Mar. 1974), p. 1.

[47]USAEDH-PAO, "Historical Summary FY 1970," I, Narrative, p. 28; USAEDH-OC, "History of the Office of Counsel," Supp. 2 (Apr. 1969 - Feb. 1970), p. 2; USAEDH-GF, "History of the Grand Forks Office," FY 1970, pp. 5-7. It is typical of the great haste prevailing at this period that OCE General Order No. 1, dated 13 January, officially established the Grand Forks, North Dakots, Area Office retroactively to the 25th of November 1969.

[48]USAEDH-PAO, "Historical Summary FY 1970," I, Narrative, pp. 22-23; USAEDH-PAO, "Information Bulletin," III, No. 1 (16 Jan. 1970), p. 1 and V, No. 10 (16 Oct. 1972), p. 2.

[49]USAEDH-PAO, "Information Bulletin," III, No. 2 (30 Jan. 1970), p. 3.

[5‡]USAEDH-PAO, "Information Bulletin," III, No. 4 (27 Feb. 1970), p. 4.

[51]USAEDH-PAO, "Historical Summary FY 1970," I, Narrative, pp. 26-27; USAEDH-PAO, "Informatin Bulletin," III, No. 7 (10 Apr. 1970), p. 1.

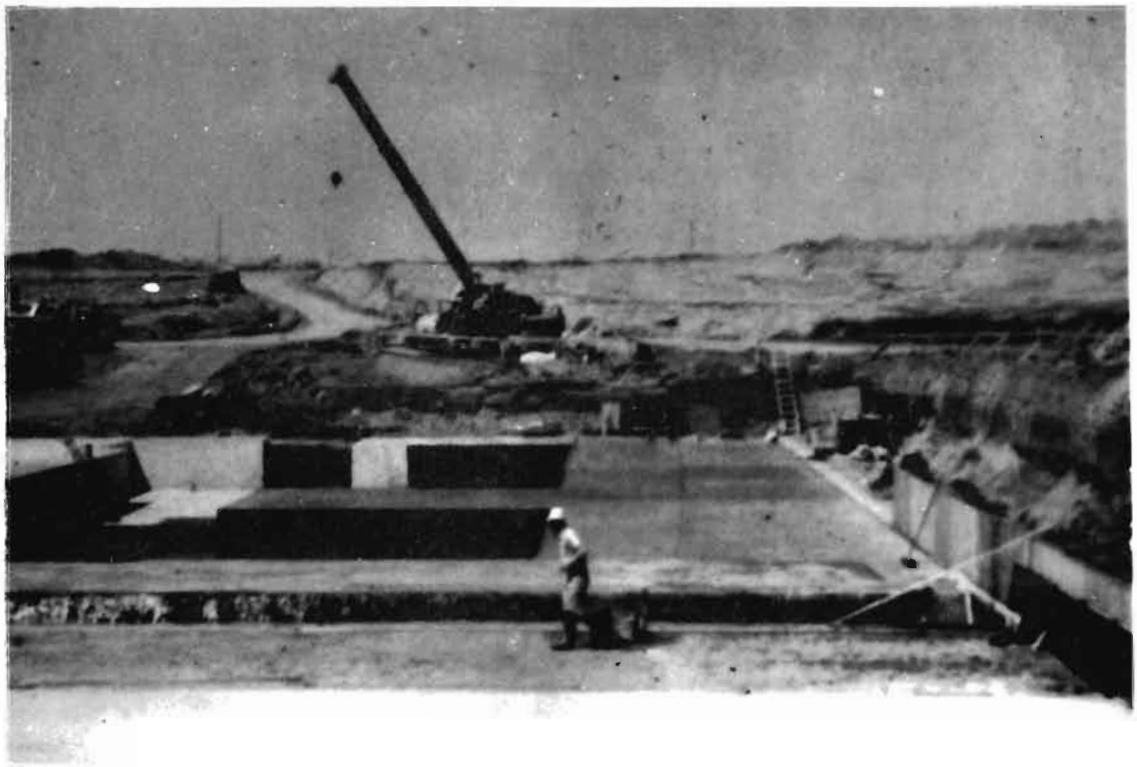
CHAPTER III

SAFEGUARD UNDER CONSTRUCTION

Construction of the first, and ultimately the only complete, SAFEGUARD ABM facilities at Grand Forks, North Dakota, commenced on Monday, 6 April 1970. The event was marked with a modest ground-breaking ceremony at the PAR site attended by William Gilfillan, Project Manager for Morrison-Knudsen & Associates; Lt. Col. Vern Davis, Assistant Area Engineer for the Corps of Engineers; State Senator Richard Forkner, R-Langdon; A.D."Doc" Poteat, M-KA's Project Superintendent on the job; and five mayors from nearby villages, A crowd of about 200 looked on while appropriate remarks were made from a bunting-draped platform, a few spadefuls of earth were turned by the dignitaries, and photographs were made. Then, without further fanfare, earthwork began in earnest.[1] By early afternoon soggy, half-frozen black North Dakota soil was being stripped away by rumbling earthmoving equipment excavating the foundations for the PAR Building and its powerplant. The same sights and sounds could be seen and heard twelve miles away as excavation got underway simultaneously for the MSR Building and its powerplant. On the next day, 7 April, Col. Roy Beatty arrived to assume his duties as Area Engineer at Grand Forks. He would supervise the project during its first three months but retired from active military service in June 1970. Col. Beatty's successor, Col. John L. Lillibridge, took over the job on 4 July and supervised its progress for more than four years. Maj. William D. Green became Area Engineer on 19 September 1974 and conducted "hand-over" operations until closure of the Area Office in June 1975.[2]

During April and May activities at both the PAR and MSR sites primarily centered about excavation and preparation of access roads. Despite the fact that a five-inch snowfall during the third week in April created a brief return of frozen ground conditions, excavation went forward quickly under ten-hour shifts working six days a week. By 1 May excavation at both the PAR and MSR sites was complete to within three feet of final grade, and final excavation proceeded during the next few days. At about the same time the first slab placements were made for the Area Engineer Office, and work was underway to assemble the first components of concrete batch plants essential for the main stages of construction.[3]

Grand Forks North Dakota SAFEGUARD construction start up 15 May 1970.



Construction underway at the Grand Forks PAR site (June 1970)

Ten days later, near the middle of May, foundation excavation and sealing for both the PAR and MSR nearly finished and forms were being placed for the first pourings of concrete subslab. At the MSR site, excavation of the deep SPARTAN missile silo holes was beginning. What at the time seemed to be a minor miracle was accomplished on 8 May when a sixty-ton crane--the smallest of three held at the Hensel siding because of road conditions--was successfully moved over the narrow, muddy, potholed county road to the PAR site. The other two machines, both of ninety-ton capacity, were not moved until 25 May. Meanwhile, erection of shops, office space, temporary utilities, and the concrete batch plants was going forward as yellow, red, blue wildflowers poked out in a brief full bloom of spring greenery.[4]

Amid these signs of initial progress and the promise of spring came disturbing rumors of a potential hiatus in the form of local participation in "International ABM Day," an anti-war, anti-ABM event planned to coincide with Armed Forces Day, 16 May. The Grand Forks SAFEGUARD sites were obvious protest targets, and the first tangible indication of demonstrations there appeared as a short article in the Fargo, North Dakota, **Forum** on Sunday, 19 April. The same announcement spread to the **Grand Forks Herald** on 21 April and reappeared in amplified detail in several area newspapers and in newscasts after 30 April.[5] By this time, spokesmen for two sponsoring groups, the "North Dakota Clergy and Laymen Concerned" and the newly formed "North Dakota Citizens for a Sane Nuclear Policy," were calling for mass demonstrations at Fargo, at the University of North Dakota campus at Grand Forks, and at the Nekoma MSR location over the weekend of 15-16-17 May. In early May, organizers announced that 2,000 persons were expected from a five state area, a crowd billed as what might become "the largest political protest ever staged in North Dakota."[6] Outside of declared visits and speeches by nationally known figures, rock music, and the planting of durum wheat seeds in a symbolic "Festival of Life and Love," the direction that the demonstrations might take remained an unanswered question to local authorities.

Because of this ambiguity, because of the social milieu then prevailing, and because dissident protests had a record of obstruction, violence, or destruction, the Corps of Engineers and M-KA viewed the forthcoming "Festival" with some apprehension. This unease was scarcely allayed by the presence of M-KA's huge, costly earthmoving equipment at Nekoma. Accordingly, as the North Dakota anti-ABM

activities took shape in early May, Colonel Beatty, representatives of M-KA, and security officers from Huntsville conferred on appropriate measures to limit obstruction or property damage on the MSR site. Policies directed from Huntsville to the Area Office advised that direct confrontations were to be avoided, including verbal exchanges or physical contact with persons participating in demonstrations at construction sites. Every effort was to be made to prevent the escalation of minor incidents into major civil disturbances or riots, while at the same time work on-site was to continue if possible.[8] Following these guidelines, the Corps chose what might be described as a cautious "carrot-without-a-stick" approach to eventualities. Local law enforcement officials were briefed and their assistance was solicited with the understanding that a bare minimum of visibility was to be maintained. On the site itself, a plot was staked off away from the yawning foundation hole for the use of demonstrators, and here portable outhouses, plastic sheeting, and even a flatbed trailer complete with electric power were provided for speakers and bands. Around the excavation itself M-KA placed simple barricades and "no trespassing" signs in hopes of passive deterrence. Finally, on Friday, 15 May, the day's shift was cancelled completely and all mobile equipment was moved off-site when it was learned that Governor William Guy would not authorized state resources for the protection of Federal property.[10]

Staring before noon on Saturday, demonstrators began to drift into the Nekoma site area. There was no rain for the first time in days, and except for a sea of mud, conditions looked good for the day's events. Early arrivals spread the Corps' polyethylene sheeting on the ground before the flatbed trailer, opened lunches, unreeled kites, and began to make themselves comfortable. By 11:30 AM, about 200 to 300 people were on the site, a figure that slowly rose to perhaps 500 by 12:30.[11] During the next two and a half to three hours the crowd milled about, flew kites or whirled Frisbees, ate and drank, sloshed in the mud, listened to rock music and danced. At least five small airplanes buzzed the site, and one youth complained that his kite had been struck by a lowflying aircraft. One of the planes dropped white envelopes containing small American flags into the crowd--the labels said, "From those who served." A local newspaper also reported that "One elderly man passed out dozens of paperback books identified on the cover as 'A Handbook for the Revolution.' It was the New Testament."[12]

Under these circumstances, the few unobtrusive Government observers found little to do except maintain a running six-hour telephone description direct to Huntsville. Most of the early afternoon was taken up with music occasionally punctuated with speeches. The entire afternoon passed quietly with no arrests or no violence.

The only vaguely tense moment came about 3:00 PM as the gathering seemed on the verge of breaking up. A female demonstator from Fargo passed out about 100 ash tree seedlings and told the group, "We're going to take these trees up to that hole and plant them where they want to plant the seeds of death." Several hundred demonstrators then marched down the road to the site to the tune of the "Battle Hymn of the Republic" played on about fifty buzzing kazoos sprinkled throughout the crowd. The marchers bypassed M-KA's barricades and "No Trespassing" signs, slipped and slid down into the muddy excavation, and planted their trees or scattered durum wheat seeds. Some then ripped up 2 x 4 lumber in place for the mud slab and laid it in the form of a peace sign, buried a tomahawk, and smoked a peace pipe while vocalizing their demands for peace. According to the **Washington Post** report, the demonstrators had originally intended to fill in the MSR hole, but nothing became of this, probably because of its size. Nekoma mayor William Verwey thought "The hole was so big they just figured it was hopeless."[14] These symbolic gestures at the excavation marked the conclusion of activities. By 3:30 the crowd began to break up a few at a time and drifted back to cars and out of the area. By 4:30 only some twenty persons remained in the bottom of the excavation debating what to do next, and by 5:40 PM the entire site was empty.[15]

Thus, the Nekoma "Festival of Life and Love" passed without incident. About the only damage done was the uprooting of forms in the bottom of the MSR excavation and the need to re-do some final grading disturbed by the passage of privately owned vehicles. Total losses were less than $1,000, not counting the day's time lost. For the protest movement, too, the "Festival" was anti-climactical since attendance was smaller than expected, no one was arrested and nothing spectacular happened to seize the nation's attention. A woman reporter from **Newsweek** perhaps summed it up best when she commented that the demonstration was a "flop" and should be considered so.[16]

Fizzle or not, the "Festival of Life and Love" in North Dakota was just one of hundreds of similar events across the U.S. during the spring of 1970, many of which were more consequential and more vociferous than that at Nekoma. Against this unhappy national backdrop, the Strategic Arms Limitation Talks, or SALT, resumed in Vienna on April 16. The

resumption of discussions did not, however, deter the Soviet Union from forging ahead with development and deployment of bigger, better missiles to achieve parity, and perhaps superiority, to the U.S. The heavy SS-9 missile in particular posed a significant and growing threat to the survival of the MINUTEMAN force, as Secretary of Defense Laird pointed out in early January. He predicted that a deployment of the SS-9 coupled with "three-part" warheads of accuracy might be able to destroy 95 percent of the American missile force in a surprise strike by 1974. Laird further estimated a current Soviet buildup of fifty to sixty such missiles a year, giving them a force of 420 in two to three years.[17] The Chinese, meanwhile, also continued to work at making their ICBM go. Even though they had not yet conducted a firing test by the spring of 1970, it seemed imminent.[18]

When inaugurating the SAFEGUARD program in March 1969, President Nixon had promised an annual review of ABM activities with an eye toward diplomatic, technological, and military developments. The first annual review during late 1969 and early 1970 indicated that the growth in both Soviet and Chinese ICBM capabilities as well as the SALT talks made continuance of the SAFEGUARD program imperative.[19] At the President's Foreign and Domestic News Conference of 31 January 1970, Nixon announced that "I have decided to go forward with both the first phase and the second phase of the ABM system, and Secretary Laird will announce the details of the program in about 30 days."[20] Within the next month, the Administration revealed a "Modified Phase II" SAFEGUARD program with a Fiscal Year 1971 budgetary request of $1.49 billion to cover continuation of Grand Forks and Malmstorm ABM sites, plus various increments of six more sites out of the original twelve in Plan 1-69. The FY 1971 request was to defend one more MINUTEMAN site at Whiteman AFB, Missouri; to commence advanced site preparation at a fourth MINUTEMAN installation at Warren AFB, Wyoming; and to do preliminary work at four additional sites, one of which was at Washington, D.C. Finally, SPRINTS amounting to two additional Remote Launch Sites (RLS) were to be added to each SAFEGUARD site to bring them up to a Phase II configuration. According to news release, the "Modified Phase II" would stretch out the SAFEGUARD program by about two more years. The result would be a stronger point defense against the Soviets plus a thin area defense against the Chinese threat, a deployment mode that clearly showed some return to the area defense thinking of early SENTINEL. An equal or more important underlying justification was the provision of "aces-in-hand" for use in bargaining at the impending SALT negotiations.[21]

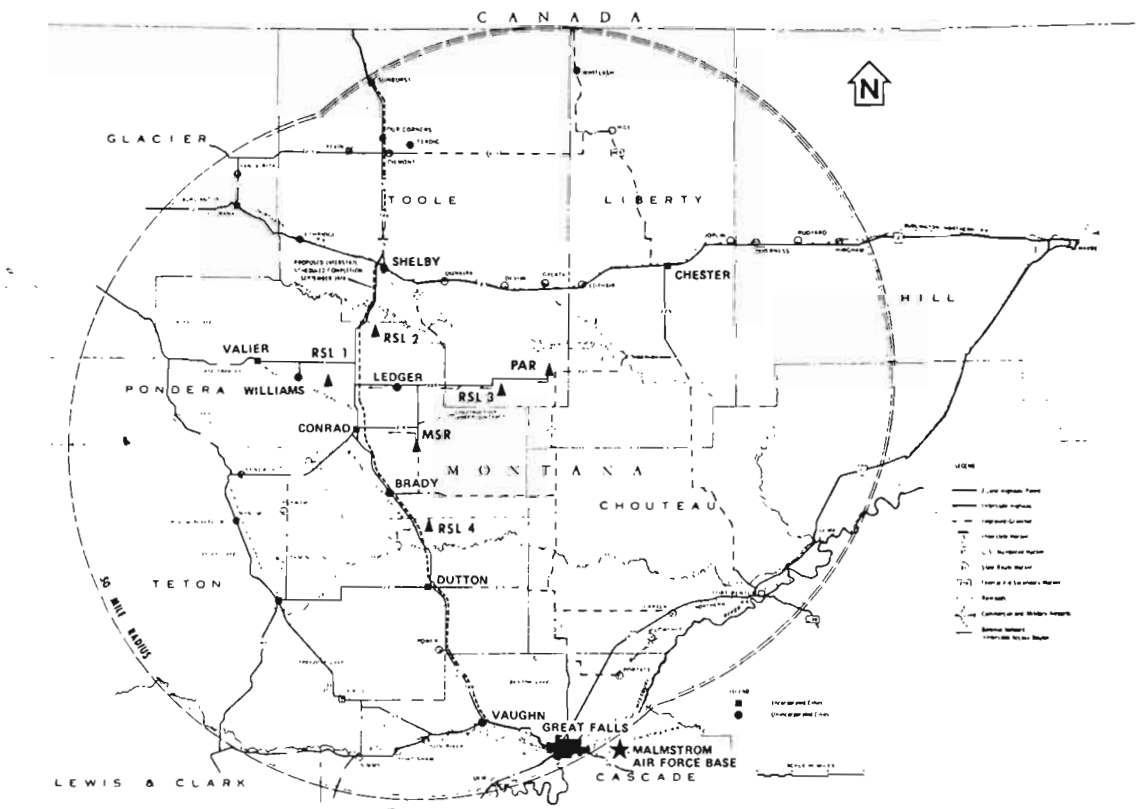
The Congressional debate of 1970 over these proposals was much less intense and public involvement much less than during the memorable summer of 1969. Nevertheless, as before, there were occasions of extended committee hearings in which all of the old ABM arguments were rehashed, and both House and Senate amendments were offered to shrink the Administration's requests. The House of Representatives passed all SAFEGUARD legislation without significant difficulty, but Senate passage was more controversial. Early in the summer, the Senate Armed Services Committee voted 11 to 6 to proceed with advanced construction at Grand Forks and Malmstorm, to begin full deployment at the third site, Whiteman AFB, and advanced site preparation at Warren AFB, but the committee cut $10 million for preliminary work at the four sites intended to provide a thin area defense against China. After three attempts to further amend this legislation on the floor of the Senate failed, the entire Congress approved the Senate Armed Services Committee's version. The compromise was adequate to sustain American credibility at SALT without going too far out on a limb of deployment that might be sawn off by some ultimate agreement on an arms limitation treaty.[22] Of the FY 1971 appropriations, Huntsville Division was authorized $271.6 million to continue SAFEGUARD facilities design and construction during the next year. A total of $12.7 million was for design and $258.9 million for construction. In addition, $6.1 million was received from other commands for reimbursable work.[23]

In practical terms, the "Modified Phase II" SAFEGUARD program authorized by Congress for FY 1971 was actually a progressive development of Phase I already underway, and while Congress debated the future of Phase II, several important milestones were passed in Phase I. In the sector of construction, a notable step was taken with the commencement of activities at Malmstrom AFB, Montana, the second SAFEGUARD site authorized in 1969. Though Malmstrom was continuously beset by various troubles which culminated in its cancellation after the SALT Agreement of 1972, its history is very much a part of the story of Huntsville Division's participation in SAFEGUARD.

Reconnaissance and site preparation for an ABM site at Malmstrom had not received much attention during the earlier SENTINEL program, and the Congressional debate of 1969 delayed the start of site

investigation and preparation even further. Once begun, however, activities were accelerated as much as possible. On 12 October 1969, Col. Lowell B. Dezarn was assigned as Malmstrom Area Engineer with his duty station temporarily at Seattle, Washington, and on 20 October the public announcement of a SAFEGUARD deployment at Malmstrom was made. The reaction in Conrad and Shelby, the two communities most affected by the news, was a mixture of quiet elation at impending opportunities tempered by trepidation at the prospect of adverse effects that might be generated by heavy construction in the vicinity. In this socially and politically conservative region there were no manifestations of protest, nor was there much extravagant enthusiasm for what some natives saw as an extension of previous MINUTEMAN construction around Great Falls into their immediate neighborhood. The first concerns that surfaced in the local press were normal ones centering mainly about the impact of incoming workers' children on the educational system or about the possible improvement of "Bootlegger Trail," a partially hardsurfaced route running north from Great Falls towards the Tiber Reservoir.[24]

MALMSTROM
MAP OF DEPLOYMENT AREA



SSC Form 46, 1 Aug 70, replaces SENSC Form 46 which is obsolete.

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As with other SAFEGUARD sites, the Malmstorm ABM facilities were strategically situated for defense of underground MINUTEMAN silos making up the Malmstrom AFB complex outside of Great Falls. The PAR and one RLS site were fifty miles away from the U.S. -Canadian border. A second RLS was also sited in Toole County, approximately twenty-eight miles west-northwest of the PAR by air and six miles south of Shelby, the county seat of Toole County. The Malmstrom MSR with attendant SPARTAN and SPRINT missile launching cells was located about seven miles southeast of Conrad, the county seat of Pondera County, putting it about sixty-two air miles south of the Canadian line. Later, after the "Modified Phase II" of SAFEGUARD was instituted, the Army planned two additional RLS sites for Malmstrom. One of these was to lie five miles northwest of Conrad, the other about ten miles due south of the MSR near U.S Hwy. 91.

The construction of these Malmstrom facilities was to proceed differently from Grand Forks. Because of pressing fiscal considerations, the SAFEGUARD System Manager determined that the Montana facilities would be built in two increments, the first and least expensive of which would largely be funded in FY 1970 and the second started with FY 1971 funds. Malmstrom Phase I consisted of site excavation and lower level construction of the two radar buildings and their associated power plants, generally including all the base slabs and the first floor level only of the PAR Building. Phase II consisted of completion of the major facilities.[25]

The geographical setting for the Malmstrom construction was remarkably similar in many ways to the situation at Grand Forks, North Dakota. The terrain around Conrad and Shelby was mostly flat or gently rolling high prairie with a cover of grass and small shrubs supporting cattle ranching or wheat farming. The climatological profile of the area was also quite similar to North Dakota, except that rainfall averaged only eight to sixteen inches per year. Summers tended to be warm and winters long and cold, with periodic interruptions brought by a warming Chinook wind blowing from the Pacific over ranges further west.

Human beings were few and far between in this isolated and sparsely populated region. The largest settlements near the construction sites were Conrad, with a population of 2,665, and Shelby, with 4,017 inhabitants. Great Falls, a city of 64,500, lay more than 60 miles to the southeast of Shelby. The only direct paved arteries crossing the site areas were U.S. 91, then only partially developed into Interstate 15, and U.S. 2 running east-west through Shelby. Fortunately, both the PAR and the MSR sites were served by nearby lines of the Burlington-Northern Railroad which ran through Conrad and Shelby.

The above conditions virtually dictated that as in North Dakota, the construction of SAFEGUARD facilities would require improved road links and a carefully engineered water supply. Improvement of the secondary road net went on through the months of March, April, and May 1970. On 17 April the Bureau of Public Roads awarded a $1.5 million contract for construction of sixteen miles of access road to the PAR, and on 15 May 1970, it followed this up with another $1.4 million contract for improvement of fifteen and two-tenths miles of county roads for other sites. The supply of water to the Malmstrom sites proved to be simpler than at Grand Forks, since a ready and fully adequate source lay nearby in the Tiber Reservoir. The Reservoir was quite some distance from the MSR, however, and in the early stages of planning it was hoped that the MSR could be tied into an expanded Conrad municipal system. The matter was broached to the town council late in April 1970, but on 15 June the council notified the Army that "we would be unable to finance such a project and also your requirements would be difficult for us to meet."[26] The Corps then decided that the best alternative would be to supply all facilities from the Tiber Reservoir via a twenty-six mile line running south to the PAR, thence west to the adjacent RLS No. 3, then southwest to the MSR. On 1 October 1970 the Corps signed an agreement with the U.S. Department of Interior, Bureau of Reclamation, for the purchase of water from Tiber Dam Reservoir. The agreement was valid for forty years and provided that the Army should pay $10 per acre-foot (325,972 gallons) of water drawn. Three weeks later a $3,177,600 contract for such a line was awarded to a joint venture of Red Samm Mining Venture, Venture Construction, Inc., and Shoreline Construction Company.[27]

The impact of SAFEGUARD on the human community in Montana also promised close parallels with the situation in North Dakota, and the Army's preliminary approach to dealing with the influx of labor and military personnel strongly resembled that taken at Grand Forks. As site investigation, mapping, and core drilling went on during November and December, five representatives of Omaha District fanned out over a fifty-mile radius around Conrad and Shelby to conduct a SAFEGUARD Community Impact Study for Huntsville Division and federal agencies such as HEW responsible for administering financial assistance.[28] Of particular interest to the

Impact Team was the effect that SAFEGUARD would have on local schools, medical facilities, utilities, and other community services. The results of the impact study were not available, however, until July, and in the meantime some residents expressed doubts that federal aid would offset the increased burden on their resources. In early spring concerned individuals and citizen's groups sought the assistance of Montana Governor Forrest Anderson and U.S. Senator Mike Mansfield in ameliorating the community impact problem. Governor Anderson visited the construction area in late July 1970, then travelled to Washington in company with North Dakota Governor William Guy to testify before the Senate's Subcommittee on Military Construction about the adverse effects of ABM on north-central Montana. Governor Anderson voiced some scathing criticisms of the Army's Malmstrom Impact Study, but many Montanans in Shelby and Conrad were at variance with his pessimistic assessment.[29] Regardless of whose opinions or estimates approached the truth in this controversy, the matters of community impact and adequate federal assistance became a moot question as the Malmstrom project became entangled in protracted labor troubles that greatly retarded the expected influx of new arrivals.

The labor troubles that dogged the Malmstrom project until its termination began to manifest themselves even before the first Phase I bids were awarded in May 1970. As at Grand Forks, Huntsville Division hoped to bring Great Falls area contractors and labor unions together in a mutual labor agreement that would stabilize costs, benefits, and conditions of work before the job actually got underway. From the beginning, however, efforts to obtain a project stabilization agreement in Montana encountered bumpy going; as time went on, the problem developed into one of the biggest, thorniest bugbears besetting SAFEGUARD's construction.[30] Eventually, the Malmstrom Phase II schedule would be delayed by about eleven months while unions, contractors, and the Government wrangled over labor issues.

Malmstrom labor difficulties first emerged at the inception of negotiations for a Phase I project agreement in April 1970. On 26-29 April Stephen V. Rohr, Huntsville's Labor Relations Officer, met with union officials, contractors, and representatives of potential SAFEGUARD bidders in Great Falls to discuss drafting a Malmstrom project agreement. In the course of these meetings, certain labor demands threatening excessive contract costs began to surface. The chief point of contention turned about local labor agreements already in force around Great Falls. These prevailing local agreements had been made in the spring and summer of 1968, after it became known that SENTINEL might be deployed at Malmstrom. In anticipation of extensive SENTINEL work lying ahead, local building trades unions negotiated local agreements calling for double time to be paid for all work over forty hours per week plus very high travel mileage rates and subsistence payments. Native contractors in the home building industry had few objections, since their jobs rarely called for much overtime or long commuting distances, but SENTINEL contractors would have been significantly affected had the program materialized.

Nearly two years later, after Malmstrom SAFEGUARD was announced and project agreements with Government ABM contractors became desirable, local Montana unions wished to insert pre-existing local contract provisions into the Malmstrom Project Agreement. At the 26-29 April meetings in Great Falls, five building trades unions proposed a tentative Malmstrom project agreement that called for double pay for overtime, together with a fixed subistence allowance running from $12 per man per day the first year to $14 per man per day the third year. As Stephen Rohr later wrote in his trip report for this April 1970 meeting, these terms would have "cost a contractor approximately $21.00, excluding salary, per day to get a common laborer to the PAR site."[31] The contractor's labor costs, of course, would be passed along to the Goverment and thence to the taxpayer. The union view was that the double pay for overtime would encourage the contractor to put more men on the job rather than pay overtime--a justification Rohr found dubious in light of the extremely small labor pool available locally. No argument except existing practice was advanced for the large subsistence payments asked. At the 27 April 1970 meeting, the attending contractors declined to accept the unions' proposals on the spot but professed that they would be bound by them if successful in bidding. Subsequent discussions came to nought, and a month later, after Phase I contracts were awarded, the two successful bidders did in fact sign a Phase I Project Agreement incorporating the status quo provisions in existing local agreements.[32]

Alarmed by the consequences of expensive labor for the costs of Malmstrom Phase II lying ahead, Division Engineer General Young wrote to the Chief of Engineers on 20 May to apprise him of the Montana labor situation. "If the [existing] union agreements prevail," General Young wrote, "we estimate that the contract costs for the technical facilities alone in Montana will increase [by] a minimum of $5,000,000

and perhaps as much as $10,000,000 if the present schedule is maintained." Furthermore, he added, "If the Phase I or Phase II contractors resist the union demands, it is our opinion that a work stoppage is probable."[33] The Division Engineer then recommended that the Federal Mediation and Conciliation Service be advised of the potentially uneconomical operation anticipated and solicited to obtain a non-inflationary agreement. The FMCS was the appropriate arbitration agency because after the October 1967 dissolution of the President's Missile Sites Labor Commission, Executive Order 11374 gave the FMCS the responsibility for resolution of potential or actual labor disputes at missile sites. In accordance with General Young's recommendations, Secretary of the Army Stanley R. Resor quickly asked the assistance of the FMCS. Resor's request was accepted by the FMCS on 1 July 1970, and discussions were pursued throughout the remainder of 1970 without achieving a satisfactory solution.

Meanwhile, construction of Phase I at Malmstrom went ahead as scheduled. On 4 May 1970 the Watson Construction Company of Minneapolis, Minnesota, was awarded a $3,369,850 contract for excavation of the MSR Building and its power plant and the construction of the first floor slab of these buildings.[34]

EXCAVATION UNDERWAY FOR THE MISSILE SITE RADAR BUILDING in July, 1970, as part of the Malstrom Montana SAFEGUARD ballistic missile defense system complex.

Two weeks later, on 19 May, a second Malmstrom contract was awarded to a joint venture of H.C. Smith Construction Company and Amelco Corporation for initial construction of the PAR facilities.[35] Smith-Amelco was to excavate the site and raise the reinforced concrete construction of the PAR Building through the completion of the second floor slab. The PAR power plant was to be completed through the first floor level. Both of the Malmstrom Phase I contracts were due for completion by 1 March 1971, and the respective contractors began work immediately in order to make the most of warm weather in the 1970 construction season.

In fact, warm, fair days were precious at both Malmstrom and Grand Forks. At both sites the priorities of the SAFEGUARD program dictated an extraordinarily rigorous construction schedule with the shortest possible time--roughly two and one-half years--allocated for completion of the building shells and installation of their tactical support equipment (air conditioning, electrical lines, cooling system, utilities, etc.). This terminal date, called the Beneficial Occupany Date (BOD), represented the Corps' major goal in the construction schedule. By the time the BOD

EXCAVATING FOR THE UNDERGROUND POWER PLANT of the Perimeter Acquisition Radar on July 10, 1970 at a site about 35 miles northeast of Conrad, Montana, as part of the Malmstrom Safeguard ballistic missile defense system complex. The work was under the supervision of the Malmstrom Area Engineer, Huntsville Division, US Army Corps of Engineers.

was reached, the weapon system contractor had to be admitted to begin installation of the radars and attendant components. Of course, in order to attain the BOD on time, it was mandatory that interim goals along the way also be met on time. Nowhere were intermediate deadlines more imperative than during the 1970 construction season at Grand Forks, where scheduling required roofing in of the first two levels of the PAR and MSR Buildings before the onset of severe cold made outside work impossible. If the PAR and MSR shells were promptly finished to this degree, work could continue on the interior during January and February 1971. If, on the other hand, the building shells were not enclosed, extreme cold and blowing snow would halt all work around the sites for at least two months during the middle of winter. This in turn would have a domino-like delaying effect on the 1971 objectives, which called for roofing in the remaining levels of the PAR and MSR, together with finishing the antenna face walls. The situation was not quite so pressing during Malmstrom Phase I, since it was never expected that progress during 1970 would be sufficient to permit interior work during the winter. With an early start on Phase II during the spring of 1971, it would be relatively easy to enclose most of the buildings during the 1971 season--or so it was hoped. As it turned out, sanguine hopes for a timely Malmstrom Phase II in 1971 foundered on persistent labor and funding troubles.

Disruption of the clockwork precision demanded in both projects might have come from several sources. A strike or other labor dispute at any point from supplier to site could have brought work to a grinding halt at any time, but the greatest threat, that of serious stoppages on the job, was reduced by Grand Forks and Malmstorm Phase I Project Agreements. Unfortunately, these pacts were not always honored, and if no major walk-offs resulted, several minor ones did. A more or less typical instance at the end of August 1970 was reported by the Division's Historian in this way:

> On 29 August, 110 carpenters walked off the day shift at the Grand Forks PAR site over a jurisdicial **[sic]** dispute with ironworkers concerning NEMP shielding installation. Thirty-eight did not report for the swing shift. All returned on 31 August. On 31 August, M-KA discharged the ironworker steward who instigated confrontation with carpenters causing 17 M-KA ironworkers to stop work. On 1 September, Napoleon Steel ironworkers walked off in sympathy. On 2 September, the International Ironworkers Representative met with M-KA and all ironworkers returned to work in the afternoon.[36]

Equally frustrating and less avoidable with the first example of technical facilities in the SAFEGUARD program was a constant flow of design changes in the buildings and their tactical support equipment. Some of these originated from changing needs of the weapons system contractors, some from revised requirements of SAFSCOM, some from the SAFEGUARD Evaluation Board, and some from deficiencies discovered in the field. The impact of change orders was particularly felt in the preparation of shop drawings which minutely detailed exactly how the contractor was going to execute the general plans and specifications. Such drawings also sometimes provided test results to show that specifications for materials and shelf items were actually being met--whether or not, for example, a batch of concrete had the desired quantities of correct ingredients and achieved stated strengths. The Corps was required to review shop drawing solutions and test results and to expeditiously approve or reject them so that the contractor might proceed without impediment to his schedule.

Facing a great number of design changes and a tough construction schedule to get the first levels of the PAR and MSR Buildings closed in before freezing weather hit North Dakota, M-KA requested in mid-summer that the Corps enlarge its engineering services at the Grand Forks sites to expedite the "turn around" handling of change orders and shop drawings paperwork. In response Huntsville Division formed a Field Engineering Action Team (FEAT) to temporarily augment the Grand Forks Area Office staff. Beginning in the first week of August, four Corps employees on TDY, together with ten engineers and draftsmen from the AE firms which designed the facilities, went to work in the Area Engineer Office. The FEAT operation grew in the ensuing weeks, taking in as many as twenty-five individuals before its dissolution at the end of October. The extent of the Team's efforts might be judged from a brief entry in the "History of the Grand Forks Office" for the period 5-11 September 1970: "During this week, 96 shop drawings were returned to the contractor, sent 183 shop drawings to Area Engineer Offices **[sic]** for review and answered 131 DDM's [Design Deficiency Memoranda]."[37]

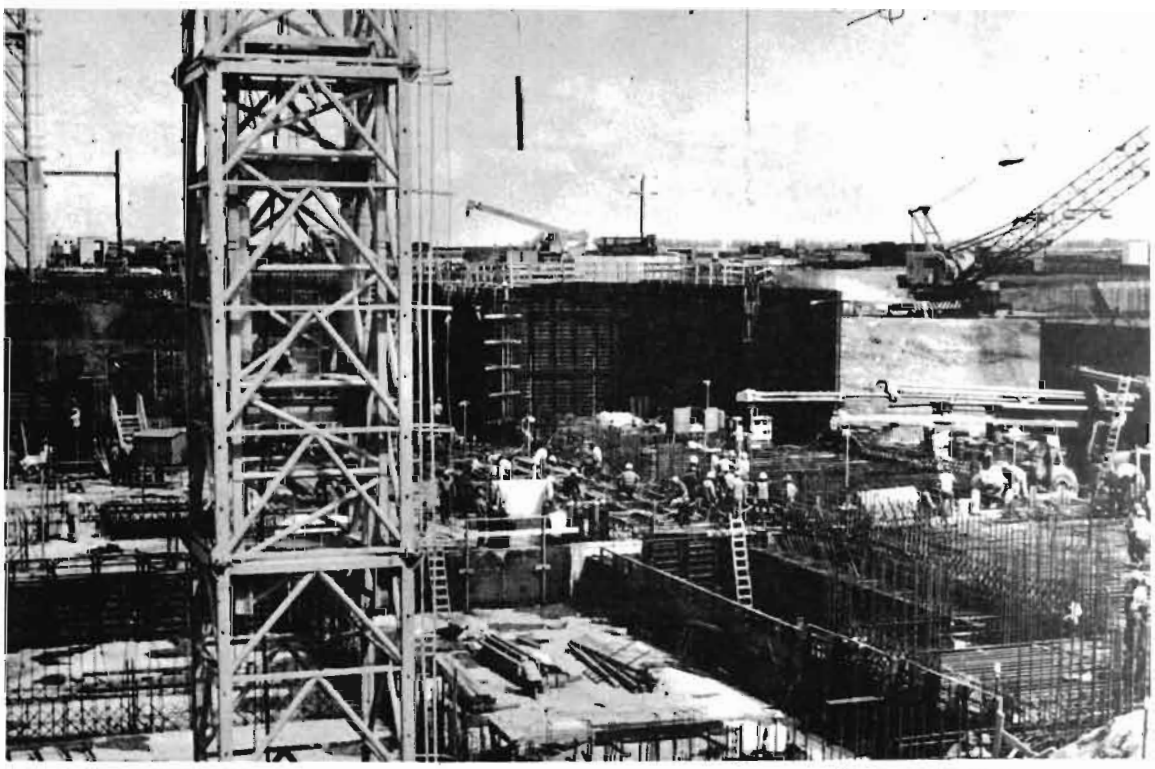
Perhaps the most aberrant, unpredictable influence on scheduling was the behavior of Mother Nature. Both Grand Forks and Malmstrom lay in zones of continental climate characterized by rather short summers with long, hot daylight hours and a lengthy,

severe winter season with days of short sunlit periods. Tempeature extremes ranged from +100° F to -40° F with frequent ground blizzards and drifting snow, and drastic drops of temperature could be experienced within a few hours' time. The transition out of winter introduced its own set of special problems, because when the ground thawed, highways became susceptible to damage from heavy loads hauled over them to construction sites. To minimize the danger, North Dakota imposed load restrictions on state highways for about sixty days during April and May, and this had to be considered in scheduling construction activity during the early spring months.

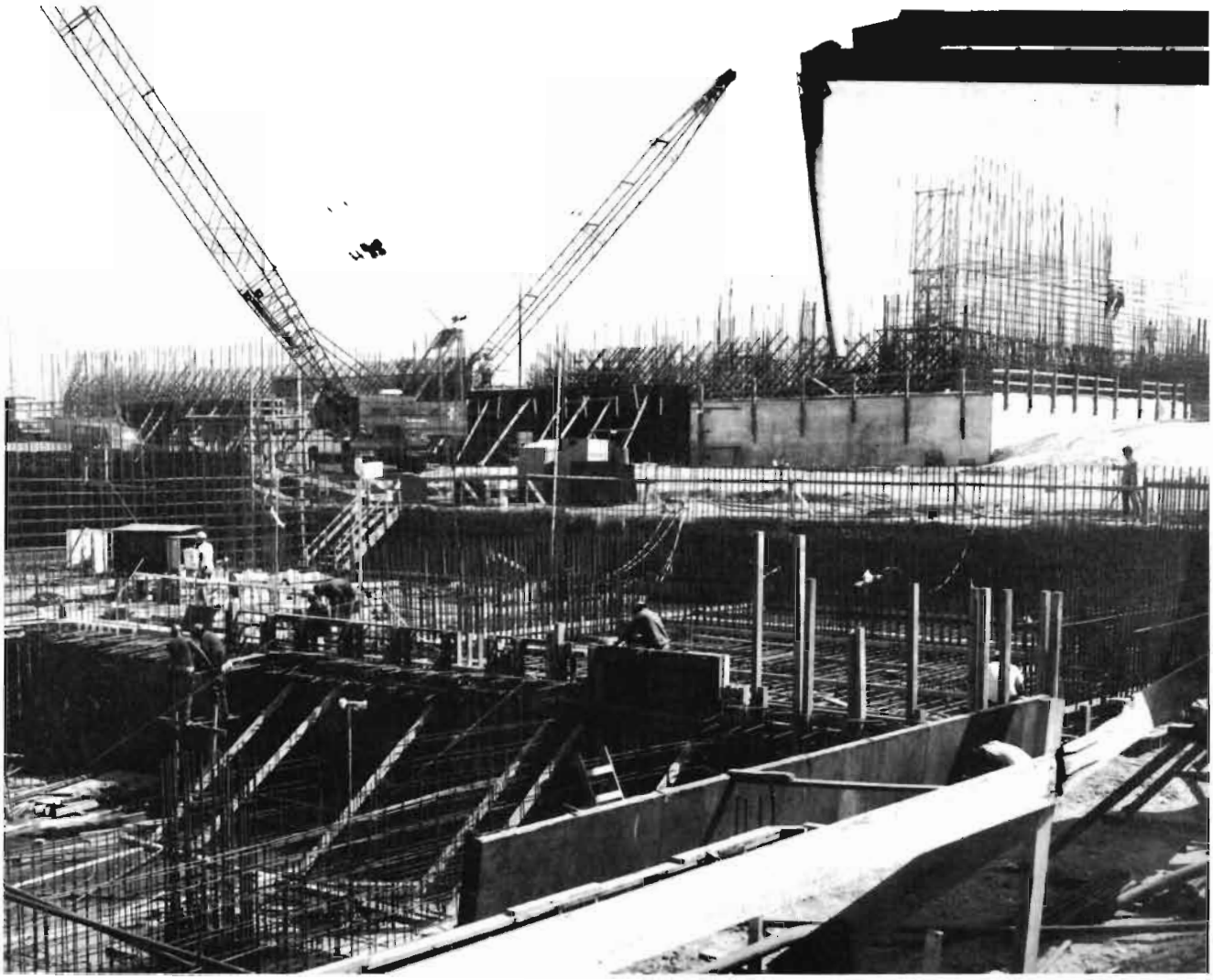
Even during the warm summer months of 1970, thoughts of winter's cold were never very far from the minds of the Grand Forks staff. Every effort, including sustained two shift operations, was made to maximize use of long, warm, dry days to drive steel and concrete placement forward as rapidly as possible. Work even went on in three eight-hour shifts under artificial lights in order to hasten the job, and M-KA's work force increased by a factor of five, from 340 men at the beginning of June to 1545 on the payroll around the first of August.

The overall results of this swift mobilization were clearly visible by the beginning of fall. The first pourings of structural concrete in both the PAR and MSR base slabs took place on 18 June 1970. By the end of that month, the PAR slab had received 2,166 yards of concrete and the MSR 750 cubic yards. At the same time, amid the pounding of carpenters and the sputter of welding torches, thick mazes of reinforcing steel were embedded for the exterior walls. By the third week of August, 12 percent of construction time had been used up in North Dakota, at which time the "Information Bulletin" could report that:

> The North Dakota sites are beehives of activity with 70% of the MSCB first floor slabs and 70% of the walls on the south and east side completed. The MSR power plant first floor slab is 60% complete and walls on the south and east side are 25% complete. Spartan cells excavation, shoring, guniting and slabs are 70% complete and installation of resteel, electrical items and exhaust duct liners initiated. The PAR building is 100% complete throughout the first floor slab. The PAR power plant forming and resteel placement for the first floor slab and northwest corner walls is 65% complete.[38]



FORMS AND RESTEEL AWAIT THE PLACEMENT OF CONCRETE at the MSCB at the Grand Forks SAFEGUARD BMD complex during summer 1970.



THE GRAND FORKS SAFEGUARD'S PAR CONSTRUCTION in mid summer 1970. Looking across the power plant which will be all underground when completed, the Perimeter Acquisition Radar buildings begins to take shape in the background.

By the second week in September first floor level slabs and walls were complete, and falsework and steel were being placed for the second floor slab in both the PAR and MSR buildings. Away from the major buildings, the onsite Area Engineer Office was occupied on 18 July; all thirty SPARTAN cells were completely prepared with blast deflectors in place by 1 September; and work was well underway on ancillary structures such as the Warhead Handling Building. The waterline from the Fordville Aquifer was also about one-third complete by this time.[39]

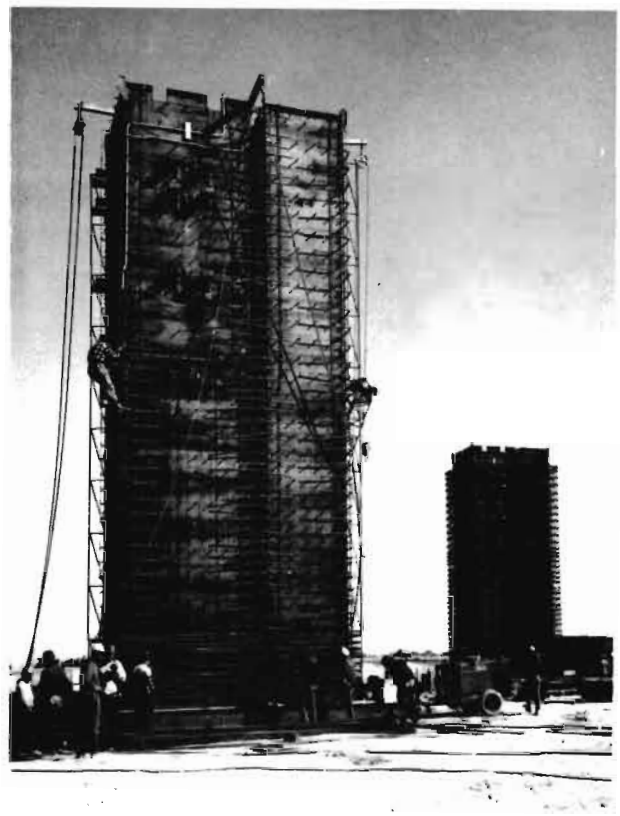
This degree of progress had consumed a total of 20,840 cubic yards of concrete in the MSR and MSR power plant and 26,070 cubic yards in the PAR buildings by mid-September. To feed the batch plants' yawning maws, M-KA received and transported forty-two rail car loads of aggregate and four car loads of cement each week during the summer.[40] These massive logistical needs were met, but not without overstressing the inadequate haul road from Hensel siding to the construction sites. Makeshift improvements in the spring of 1970 proved insufficient, and so did constant oiling and grading afterwards. By Mid-July the Area Office historian could write in direct fashion that "everyone is complaining" about the annoyance and hazards of dust clouds.[41] The mayor of Nekoma felt obliged to go beyond complaints: on 18 October he imposed a 12,500 lb. per axle limit on truck traffic through his hamlet. Inevitably, this created a supply bottleneck

near the MSR. Unable to obtain a retraction of the load limit, M-KA decided to literally bypass the problem by contructing a haul road around Nekoma. In February 1971 a more or less permanent solution to dust on the Hensel haul road came with the decision to asphalt the surface. Laying of the thirteen miles of pavement began on 17 June 1971 and was completed on 8 August.[42]

By the beginning of fall in North Dakota, significant progress had been made in starting up and accelerating the Grand Forks job. Unfortunately, however, despite initial successes a slippage of a few days found its way into the schedule. Part of this was caused by unforeseen incidents such as the loss of a day's work during the anti-ABM demonstration in May, and part was due to weather conditions such as a 1.76 inch rainfall recorded on 8 and 9 September. A tremendous number of change orders and a backlog of hundreds of Design Deficiency Memoranda also took their toll. In late Setpember, for example, the Area Office historian noted that "the FEAT Team, though diligent, still has a backlog of 1,054 DDM's."[43] Minor labor disputes and walk-offs introduced further delays of a few hours to a day or two, as did a serious shortage of carpenters. By the third week in August, M-KA estimated it needed about 100 carpenters, and when these were not forthcoming, it initiated a two weeks' on-the-job training program to train apprentices.[44]

The growing schedule slippage, together with the arrival of near-freezing temperatures around the first of October, served to crystallize a "major concern [in the Corps of Engineers]. . . that the four (4) main structures will not be completed through the second floor slabs by winter shutdown."[45] Accordingly, Huntsville Division initiated discussions over the terms of schedule adjustments necessary to bring enclosure before winter. On 10 October Col. Robert McBride, the Division's Contracting Officer, wrote to M-KA proposing that the joint venture should accelerate certain aspects of the work for a limited period to insure that the major buildings were closed before winter set in. The accelerated phase would continue until enclosure was achieved, until the prevailing situation made this impracticable, or until the Government directed that the additional effort should cease.[46] M-KA responded in the affirmative, and an accelerated effort at Grand Forks continued for about six weeks. During this time two ten-hour shifts were worked six days a week. The speed-up was terminated on 19 November when Colonel McBride wrote to M-KA stating that "the progress made to date is such that accomplishment of the Government's objectives in directing this acceleration is assured."[47]

In compensation for the increased effort and attendant inefficiency costs, M-KA was allowed an additional eighteen days to complete the MSR Building and twenty-two more days to complete the PAR Buidling, plus negotiated cost settlements of roughly $2,500,000.[48]



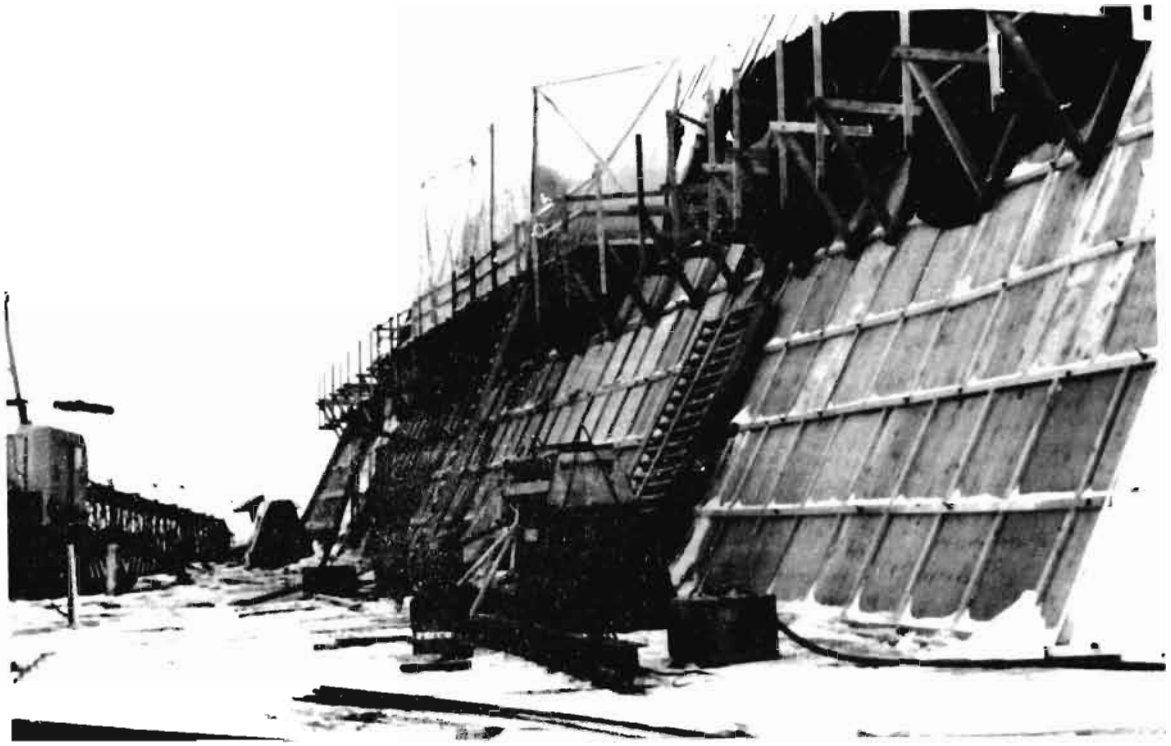
43 FEET HIGH MIDSECTION of the SPARTAN launch tube and exhause chamber being prepared for insertion into the SPARTAN launch cell at Grand Forks, MSR site during October 1970.

MSR SITE at Grand Forks, North Dakota with missile field in the foreground. Town of Nekoma is at upper right. (October 1970)

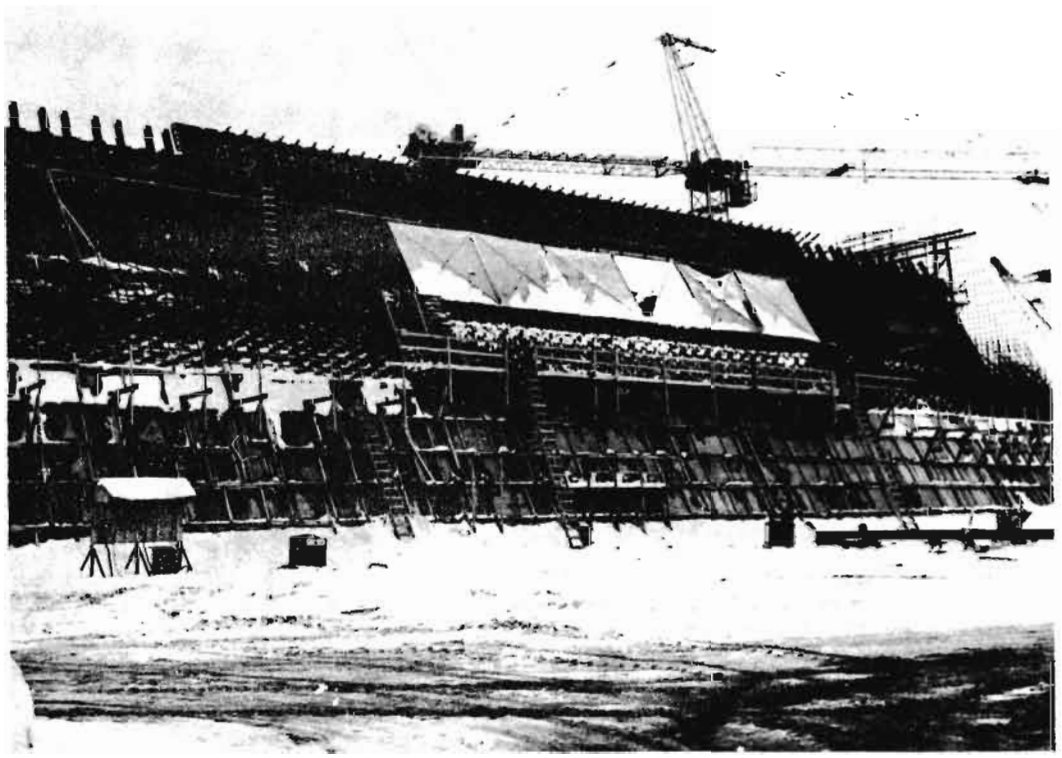
SQUARE HOLES FOR ROUND PEGS at the Spartan missile field of the Grand Forks SAFEGUARD BMD complex near Langdon, North Dakota, in October, 1970. The tall tower at the left rear of the field is a Spartan can surrounded by reinforcement steel. The unit will be lowered into one of the many square holes where it will receive concrete placement. The round Spartan missile will eventually be housed in the square reinforced concrete silo.

In the meanwhile, just as the accelertion began, the first traces of snow were recorded at Langdon on 13 October. On 29-30-31 October an inch of snow blanketed the ground, and plans for winterization began in earnest. Since concrete continued to be mixed and poured at the MSR until the second week in December and at the PAR site until 24 December, careful measures had to be taken to protect men and materials from North Dakota cold. The magnitude of the climatic problem can be judged from conditions prevailing when concrete pouring ceased in December. At that time eight inches of snow lay on the ground, and on the night of 20 December temperatures had dropped to -25° F. The **highest** low in December was 13° F above zero on 1 December, while on both the 20th and the 23rd temperatures had only risen to -7° F in the heat of the day. These still air temperatures could be and often were greatly multiplied by the chill factor of anything from prairie breezes to gale force blizzards.[49]

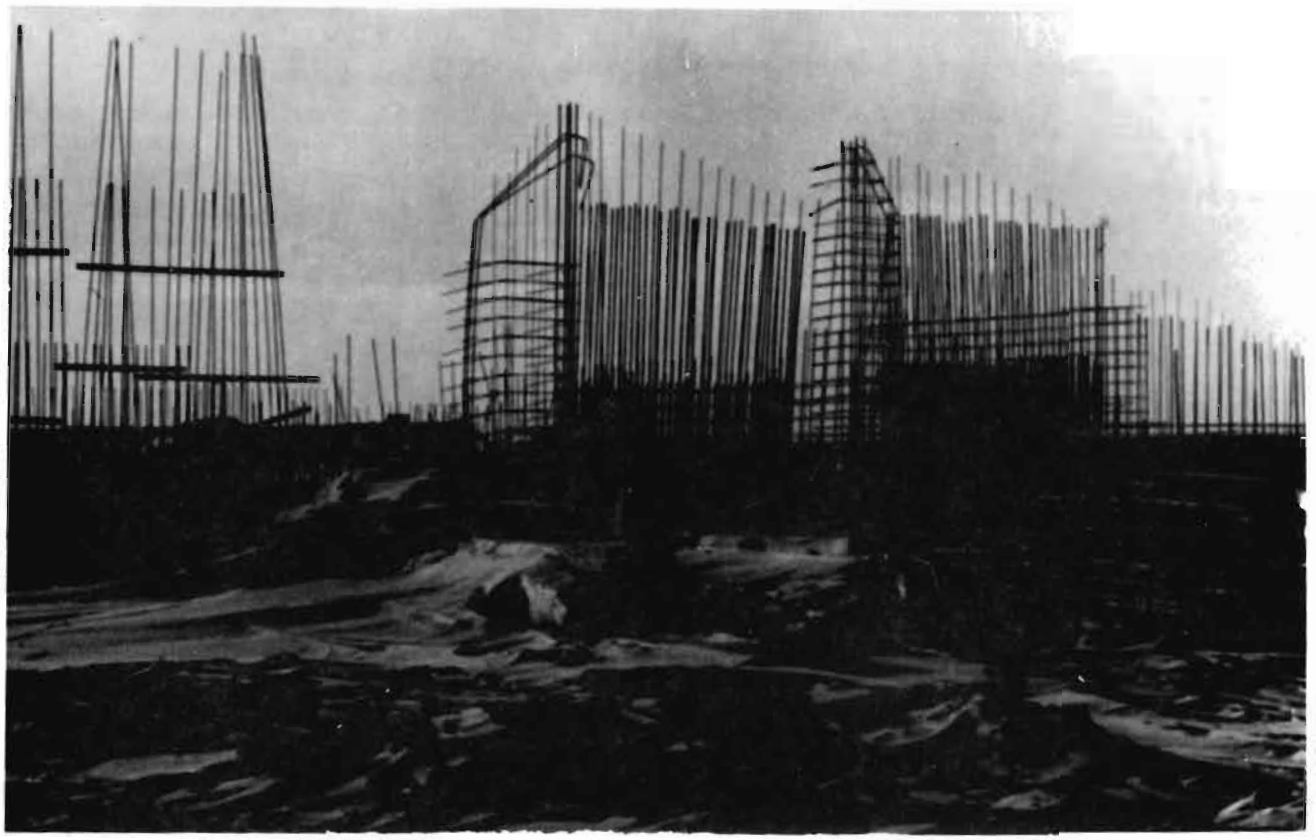
GRAND FORKS, NORTH DAKOTA MSCB closed for winter (Dec. 1970)



GRAND FORKS PARB "A" wall winterized in (Mar 1971)



NORTH WALL OR FACE OF THE GRAND FORKS PARB showing the radar penetration holes. The face slants back at a 25-degree angle and will rise over 125 feet in the air. (Mar 1971)



GRAND FORKS UNIVERSAL MISSILE BUILDING (Dec 1970)

For construction crews in North Dakota, the only choice was to learn to live with the demanding conditions. Cars had to be equipped with block heaters and anti-freeze and many acquired supplemental interior heaters. Studded snow tires, regular snow tires, chains, tow cables, booster cables, parkas, heavy woolen sweaters, "long john" underwear, mufflers, gloves, and mittens were all part and parcel of recent acquistions for some southern newcomers. Equipment and working places, too, had to be protected, and even raw materials such as aggregate stored outside had to be protected from freezing in order to be usable.

As mention above, the major step for winter work at Grand Forks was closure of the four major buildings. The last structural concrete placements in these was made on the second floor of the PAR Building on 23 December 1970. Closure of the first floors of the other three buildings had been reached previously. With the first floors enclosed in concrete, a sheltered base was established to allow inside work. But concrete alone provided little relief from the hostile tempertures of a North Dakota winter. There were still many openings left in the lower levels of the building shells, and the concrete itself had to be protected during the mixing, transport, pouring, and curing phases.

The first item on the winterization agenda was the preparation of concrete. The batch plants were protected with plywood and polyethylene sheeting, while water and aggregate also had to be kept from freezing. The trucks transporting the mixed concrete to the pumping and conveyor areas were all equipped with insulated drums, while the pumping stations and conveyors were also protected with external insulation. Once placed in forms, the freshly poured concrete had to be kept at approximately 50° for the required fourteen-day curing period. This was done by erecting temporary shelters of plywood, styrofoam, and polyethylene over the area to be poured. During the pour and fresh curing period of a day or so, propane space heaters with electric blowers were used to force warm air into the area. Huge blankets, tarpaulins, and hay bales were used to protect the concrete in the later curing stages. Once the concrete had set and cured, the shelters were stripped away, moved to the next placement area, and re-erected.

Next to be tackled were the interiors of buildings. If any effective inside work was to go on during the winter, workmen had to be provided some semblance of a comfortable environment and the materials they were using protected. To do this, gaping openings to the outside were sealed off with formed wood closures and bolts of polyethylene sheeting. Then M-KA personnel installed huge two million BTU gas-fired furnaces in each structure. The furnaces' electric blowers forced warm air through yards of ducts into most of the nooks and crannies of the maze-like interiors. Chilly corners and drafty working spaces were further warmed by numbers of portable bottled liquied propane heaters as needed. The result was a tolerable 55° F temperature inside, sufficiently warm to allow work to proceed under "gloves-off" conditions without bulky clothing or numbness of extremities. Even miscellaneous concrete pouring on the interior could be placed in warmth from portable mixers rolled about within the structures.[50]

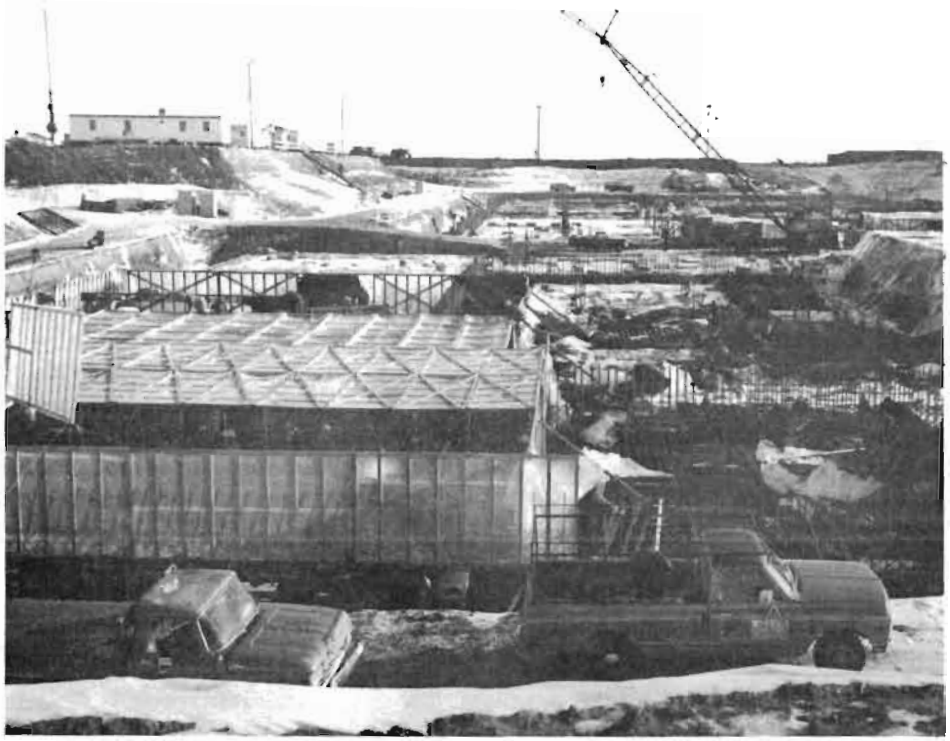
The successful implementation of winterization methods at Grand Forks during November and December could be measured in the smooth transition to in-house work of various kinds when outside conditions became intolerable. Fabrication, installation, and painting of conduit and heat sink cooling lines began in Mid-Novermber; about the same time generator pedestals and their massive anchor bolts were emplaced in the MSR Power Plant floor. As early as October the meticulous job of cutting, placing, and welding liner plate for the NEMP shielding had begun in individual rooms of the MSR Building, and the activity took hold in the first level of the PAR Building during the last week of December. The installation and welding of the liner plates was followed almost immediately by painstaking magnaflux testing to insure that finished welds were without flaws, gaps, or cracks that could compromise the continuity of the shielding. Quite naturally, these types of indoor activities meant not only a reduced work force but also one that was different in composition. During the week of 1-7 January, 1971, for example, the average M-KA manpower on the job was 266 salaried and 497 craft employees, for a total of 763. Most of the craftsmen were ironworkers, electricians, or plumbers as contrasted with a preponderance of masons, carpenters, and laborers seen earlier in the year.[51]

As the 1970 construction season closed, it could be fairly said that most of the major goals for the first year at Grand Forks had been met. The four main structures had all been sufficiently advanced to permit interior work to continue without interruption. In so doing, over one million cubic yards of earth had been excavated and equally enormous amounts of construction materials hauled, prepared, emplaced, and finished . A statistical recapitulation published for Division employees in the 15 January 1971 "Information Bulletin" reported that

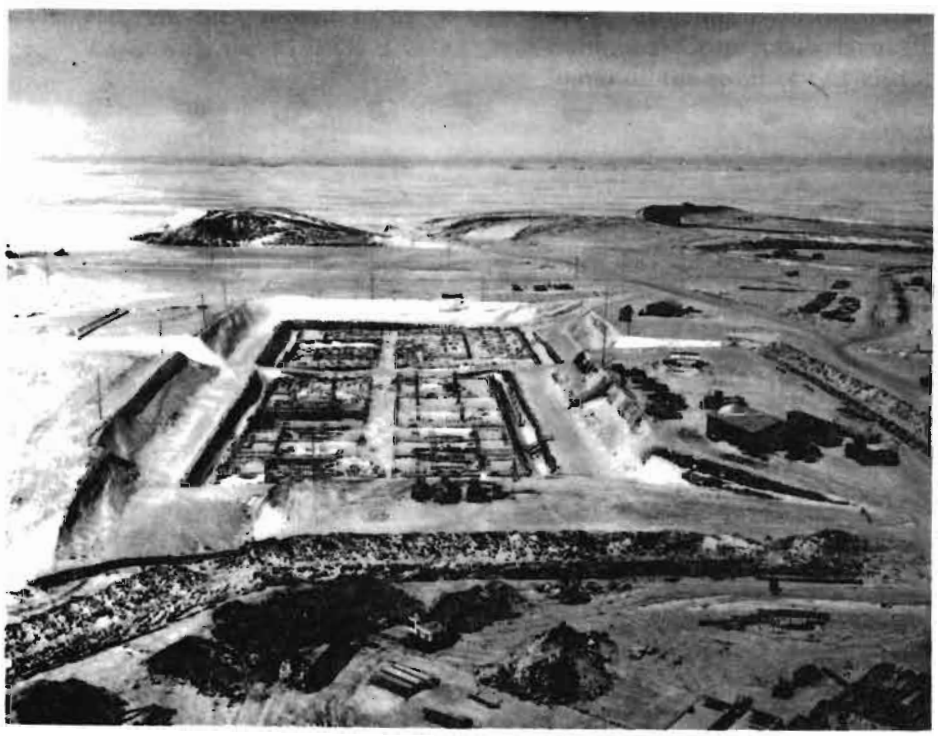
> the Grand Forks, North Dakota, facilities had a peak employment of over 2200 people who have place 24,749 cubic yards of concrete and 7.8 million pounds of steel in the PAR Building; 13,454 cubic yards of concrete and 5 million pounds of steel in the PAR Power Plant; 18,689 cubic yards of concrete and 6.3 million pounds of steel in the MSCB; and 14,404 cubic yards of concrete and 3.3 million pounds of steel in the MSR Power Plant.[52]

In addition, the "Bulletin" went on, over twenty miles of roadway had been built or improved, a rail siding installed, sixty-one miles of water pipeline laid as well as construction of contractor and Area Engineer Office facilities.

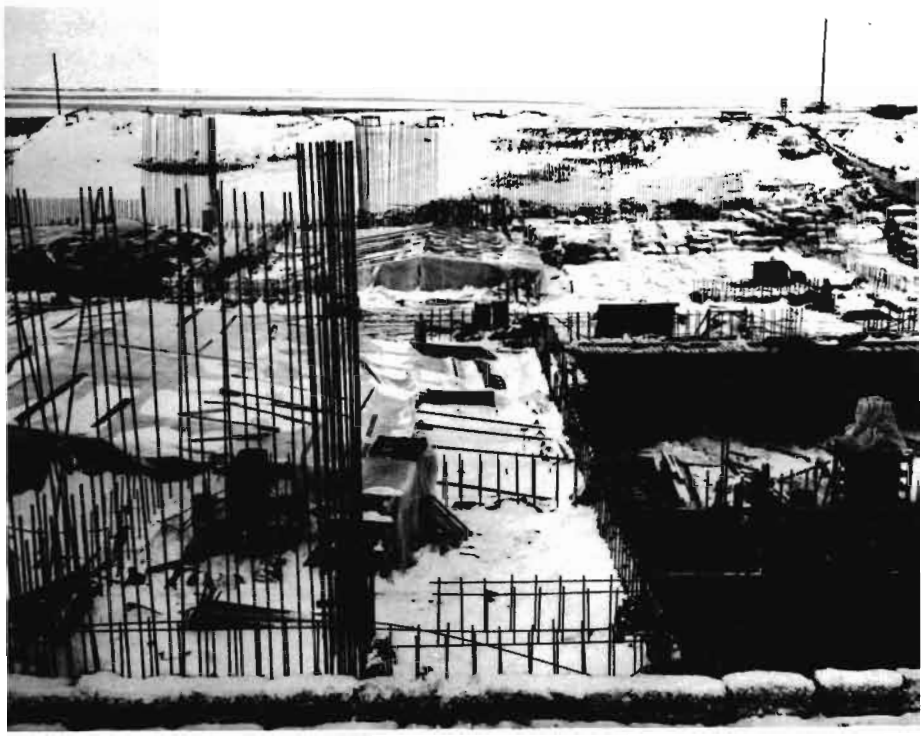
An end-of-the-year summary for Malmstrom AFB could also report significant progress with the completion of the Phase I contracts. The MSR site major concrete work under Watson Construction's contract was essentially finished on 12 January 1971 with completion of the preparatory features, foundations, and reinforced concrete in the first floor slabs of the MSR and MSR Power Plant and construction of a 20,000 square foot Area Engineer Building. On 26 February the final concrete pourings were made on the PAR Building's Phase I by Smith-Amelco. By that time, visitors to the Conrad-Shelby sites could see guant white concrete shells reaching from ground level up through the second floor slab of the PAR Building and its power plant, while out of the top surfaces rows of heavy reinforcing rods, piping, and other protrusions awaited the commencement of Phase II. Near the incomplete PAR a Resident Engineer Office stood empty but finished, complete with a large paved parking area. Despite outdoor work in temperatures that sank as low as -35° F during January, both Watson Construction and Smith-Amelco had met their required schedules, Smith-Amelco only being allowed a four day extension for change orders, weather, and other excusable delays. Neither contractor encountered difficulties in cleaning up the sites and carrying out other minor finishing operations before the BOD of 1 March.[53]



CANOPIES PROTECT WORKERS during subzero weather at the Malmstrom SAFEGUARD BMD system MSR complex being built in Montana. With portable heaters the temperature inside the work area rise to about 55 degrees while it is below zero outside.



THE MSR SITE being constructed near Conrad, Montana, as part of the Safeguard BMD system, as it appeared in March, 1972. In the center foreground is the straw covered base slab of the power plant with the base slab of the MSCB immediately above.



PERIMETER ACQUISITION RADAR POWER PLANT being constructed near Conrad, Montana, winter 1970. The canopied working areas and straw covered perimeter are part of the winterization plan to permit construction activities and concrete placement during the sub-zero winter weather of the Montana prairies

THE MALMSTROM PERIMETER ACQUISTION RADAR site as it appears looking from the southwest after completion of Phase I construction and clean-up. The control building is center with the straw covered base slab of the power plant on the right. In the background is the water reservior and tank.

Unfortunately, the timely completion of Phase I at Malmstrom became meaningless as Phase II became ensnarled first in unacceptable bid offers and then in complex labor troubles that disrupted what should have been a smooth transition out of Phase I. During preparations for the Phase II bidding process in late 1970, it became evident that SAFEGUARD construction costs were rising steeply and would probably continue to do so throughout the bidding period in early 1971. In part, this trend was caused by inflation throughout the nation's economy and in part, to factors peculiar to SAFEGUARD's advanced technology and isolated construction locations. One means of combatting the upward cost spiral was to encourage maximum bidding competition for Malmstrom Phase II by offering separate bidding opportunities for the PAR facilities and for the MSR group. Accordingly, a unique bidding arrangement was worked out for this job. Three Phase II bidding schedules were provided in the Invitation for Bids: Schedule I, PAR facilities alone; Schedule II, MSR facilities alone; Schedule III, PAR and MSR facilities together. The Government reserved the right to award two contracts under Schedule I or Schedule II or one comprehensive contract under Schedule III, accepting the bid or combination of bids most advantageous to the Government. The major disadvantage was to complicate contract administration in the eventuality that the two contract plan materialized.[54]

The more complex bidding schedule then for Grand Forks meant that the Malmstrom Phase II bid package outweighed the previous January 1970 record set for the North Dakota sites. When Invitations for Bids were mailed on 7 January 1971, the total Malmstrom bid package weighed 125 tons, including 1000 sets of half-size drawings weighing 201 pounds per set and 1200 sets of specifications weighing 39 pounds per set. Printing of this package was done by the Army Missile Command Printing Plant at Redstone Arsenal with compilation and distribution carried out within the Division.[55]

Bid opening for Phase II was conducted in Seattle, Washington, on 25 March 1971. Only two bids were recieved, the apparent low bid of $178,980,000 being submitted by a joint venture sponsored by Peter Kiewit Sons' Con. and Associates (PKS&A), of Omaha, Nebraska. Other members of the venture included Morrison-Knudsen, Inc. (contractors at Grand Forks), and Fischback and Moore, Inc., of Denver, Colorado. The second bid was from a joint venture sponsored by Mid-Valley, Inc., of Houston, Texas, in the amount of $202,832,000. Since the Government had estimated the iob could be done for $152,175,000, the low bid submitted by PKS&A exceeded expectations by more than 17 percent. Three weeks later, on 14 April 1971, Under secretary of the Army Thaddeus R. Beal rejected the low bid, ruling that it was "unreasonable in price." Under authority of 10 U.S.C. 2304 (a) (15), Huntsville Division then extended new solicitations to the only two interested bidders on 26 April. Actually, the former Invitations For Bids was converted into a Request For Proposals with a closing date of 17 May 1971.[56]

The two joint ventures and the Army, however, found it impossible to come to terms on a fixed-price contract for Malmstrom Phase II, and a delay of more than eight months ensued before a bargain was struck. The reasons for the delay were extremely complex, involving conflicting interests among several Government agencies, the construction contractors, and local and national unions. The differences among these parties actually stemmed from two interacting causes, inflation in an overheated national economy brought about largely by the Vietnam War and social expenditures, and the desire of labor to keep pace with, or even to better, its position in an era of rising prices. The strictures of a narrow Presidental economic policy further complicated settlement of issues after 3 April 1971 when Executive Order 11588 set ceilings on prices and wages in an attempt to stablize the economy. Later in the year, Executive Orders 11615 and 11627 effectively extended a "freeze" on economic adjustments amounting to more than about 6 percent per year.

The hiatus in Malmstrom Phase II began with the failure to achieve a Phase II project agreement before bids were offered in March 1971. This failure really dated back to Phase I. It will be recalled that the Phase I Project Agreement signed in May 1970 had incorporated very high wage and subsistence rates which alarmed the Army with ominous implications for Phase II. Throughout much of 1970 the FMCS had been trying to arrive at some compromise between earlier union demands accepted under Phase I and wage levels acceptable to the Government and its contractors. The FMCS had not been able to break the impasse during 1970, nor had any progress been made during initial contractor-union negotiations for a Phase II agreement in January and February 1971. At the time the issues remained fundamentally the same as under Phase I, as the Secretary of the Army reported to the FMCS on 1 March 1971:

> Prospective bidders and local unions began negotiating for a project agreement on January 26, 1971. No project agreement has yet been reached negotiations are scheduled

to resume on March 8, 1971. The prospective bidders have reported that the Montana unions are demanding as much as $2 per hour per year increases over their current wages, double time for overtime, subsistence of $20 per day, and 10¢ per mile travel allowance round trip.[57]

The Secretary then went on to elaborate the disastrous impact that these askings would have on the costs of Malmstrom Phase II and on SAFEGUARD as a whole:

> If these increased labor costs agreed upon for Malmstrom as discussed above were reflected in all future project agreements for SAFEGUARD construction contracts, the impact would be very substantial. The potential increase in the contract for the Malmstrom major technical facilities (the PAR, MSE, power plants, and collocated missile facilities) would approximate $25 to 30 million. If these rates were applied to all remaining construction contracts at Malmstrom (for non-technical support facilities, remote launch sites), the net increase in construction costs would be about $40 to $45 million. It is reasonable to assume that the already sizable potential increase in costs would be further multiplied if comparable wage rates and benefits were applied to construction at the Whiteman AFB, Missouri site and at any later sites, if authorized. Further, these potential increased costs could affect the adequacy of the availability of funds and impair the current deployment schedules.[58]

No further progress towards a satisfactory project agreement had been reached three weeks later when PKS&A and Mid-Valley, Inc., submitted their bids for Phase II with contingencies for anticipated cost increases over Phase I.

Efforts to formulate an agreement between the two prospective contractors and Great Falls labor union locals continued through April and May, and eventually an agreement was concluded with nine of the fourteen local building trades. Under the guidelines of prevailing Executive Order 11588, however, the watchdog Construction Industry Stabilization Committee, or CISC, had to review the wage and benefit package for potential inflationary effects violating the President's annual 6 percent parameters. When the Committee finally reached a decision on 29 July 1971, it found the proposed increases not acceptable.

There was now but one alternative remaining for the Army, to attempt to secure an agreement with national union representatives with the hope that the North Central Montana Building and Construction Trades Council would consider it binding in Montana. In August the Secretary of the Army requested the assistance of the Secretary of Labor to bring the parties together in Washington, D.C., and as a result, the Chairman of the CISC, together with the national presidents of the individual building trades union and the Brotherhood of Teamsters, entered into negotiations for an acceptable project agreement.

Throughout the summer and early fall, contract negotiations also continued between prospective contractors and the Corps of Engineers. On of the two prospective joint ventures, Mid-Valley, Inc., withdrew from consideration on a fixed-price basis in September. Subsequently, a general understanding on price was reached between PKS&A and the Huntsville Division with formal contract award contingent upon obtaining a satisfactory labor agreement.

During these negotiations, a general Malmstrom AFB Phase II Project Agreement was concluded during late October. The pact was signed by the President of the Building and Construction Trades Department, AFL-CIO; the prospective contractor, PKS&A; and the national presidents on the unions involved on 19 October 1971. The provisions included a maximum travel, subsistence, and related allowances of $9.00 per day to RLS No. 4 and the MSR site and $12.00 per day beyond the MSR, to the PAR site, and to RLS's Nos. 1, 2, and 3. Though above the 6 percent annual increased guideline laid down by President Nixon's economic policy, the document was approved by the CISC the next day. The question now became one of whether the local unions in Montana would honor an agreement negotiated on their behalf at national levels. Until this acquiesence was clearly forthcoming, PKS&A decline to enter a definitive fixed-price contract.[59]

As of the first of December 1971, the chain of events outlined above had generated a slippage of at least eleven months in the Equipment Readiness Date for the Malmstorm site. Further delay would have seriously jeopardized effective use of the 1972 construction season with concomitant additional slippage and increased costs. Thus, on 2 December a temporary Letter Contract (DACA87-72-C-0019) was drafted and issued to PKS&A. In effect, this was an authorization to begin work, with maximum expenditures on the part of the Government limited to $20 million, obligations limited to $50 million, and an understanding that a definitive fixed-price contract for

the entire job would be forthcoming within ninety days. Meanwhile, as the Letter Contract went into effect, PKS&A attempted to obtain compliance with the Project Agreement from local unions.[60]

By 18 February 1972, only four local unions had subscribed to formal arrangements with PKS&A; nevertheless, the venture felt secure enough to proceed into a final contract. On 24 February, PKS&A accepted modification PZ0004 to the Letter Contract of 2 December 1971, thereby contracting Malmstrom Phase II for a fixed-price of $160,927,932. This contract superseded the Grand Forks contract as the largest award made to that date by the Corps of Engineers. It had come almost exactly 11 months after the 25 March 1971 initial opening of bids for Phase II.[61]

The resumption of work in Malmstrom was to begin as soon as the weather permitted, with the first concrete placement scheduled for April. It was anticipated that during the 1972 season outside construction work on the PAR Building would be completed through the third level of the five-story building, with half of the fourth floor level walls in place. This would require a season's placement of 16,000 yards of concrete, a reasonable goal considering the 1970 performance at Grand Forks. The PAR Power Plant would be one-third roofed in with 10,000 yards of concrete placed. The MSR was to be completed through the second level slab, or up to the turret base, with 8,000 yards of concrete placed, and the power plant would be one-third roofed in, with 11,000 yards of concrete placed . Inside work was to continue throughout the year. There would be approximately 1,500 contractor and construction personnel on the sites during the summer of 1972. The Malmstrom facilities were to be completed by late 1974, and the complex was to become operational in

Contract signing on 24 February 1972 for a $160,927,932 Phase II Malmstrom Contract between Peter Kiewit Sons' Company and Associates (PKS&A). Government reprsentatives include Ben Porter, Project Coordinator (standing left), Colonel Lochlin W. Caffey Contracting Officer (seated) and Brigadier General Bates C. Burnell, Division Engineer, (standing right).

1976.[62]

With the breakthrough in awarding the main structures under Phase II, the remaining contracts pertaining to the site were let very quickly thereafter. The first two RLS sites, Nos. 2 and 3, were let on 10 April 1972, and on 20 April a contract for the Malmstrom Non-Technical Support Facilities was let to Chris Berg, Inc., Seattle, Washington, for $10,717,000. Finally, contract for RLSs 1 and 4 was awarded on 5 May. As events were to show, however, neither the major PKS&A contract nor the lesser ones following progressed very far before events in the international arena terminated them.[63]

Had the remainder of the SAFEGUARD program experienced the ill-luck encountered in Montana during 1971, it might well have capsized from Congressional criticism and public pressure. This was not the case, however, for outside of Malmstrom's problems, the SAFEGUARD program enjoyed a good year during 1971. Early in the year, President Nixon's staff conducted the second annual SAFEGUARD review in the light of contemporary Soviet and Chinese arms advances and pondered the ABM program's weight at the SALT talks. When the Administration's budgetary decisions for FY 1972 were publicly announced on 9 March they revealed an outlook of guarded optimism that an American-Soviet consensus would eventually be reached in strategic arms limitations. The Presidental budget proposed to the Congress included $1,278 billion for the SAFEGUARD program, a sum essentially intended to sustain ABM construction at FY 1971 levels. The previously authorized sites at Grand Forks, Malmstrom, and Whiteman AFB, Missouri, were to proceed as scheduled, and funds were to be provided for a fourth site, also authorized a year before. Depending on SALT trends, however, the President wished to hold open an option on placing the fourth site at Warren AFB, Wyoming, as previously planned, or constructing it outside the nation's capital. The Administration's proposals fared well in the Congress, which contented itself merely with trimming $161 million from SAFEGUARD and directing that the fourth site deployment should be at Warren AFB for reasons of economy.

Out of the FY 1972 Congressional ABM allocation, the Huntsville Division received $131.6 million to continue SAFEGUARD facilities design and construction. Of this amount, a total of $0.7 million was for design effort and $130.9 million for construction. In addition, $12.7 million was received from other commands for reimbursable ballistic missile defense work, while the Division's FY 1972 operating budget amounted to $10.7 million.[64]

Within the Division, the advancement of SAFEGUARD during 1970 and 1971 was marked by corresponding changes in personnel and organization. On 28 November 1970, Brig. Gen. Bates C. Burnell assumed the position of Division Engineer when General Young was transferred to Vietnam. The new Division Engineer had joined the Huntsville Division as Deputy Division Engineer on 9 March 1969 from a Vietnam assignment as Commander of an Engineer Construction Group. A 1945 graduate of West Point, General Burnell also held a M.S. in Civil Engineering from Massachusetts Institute of Technology.[65]

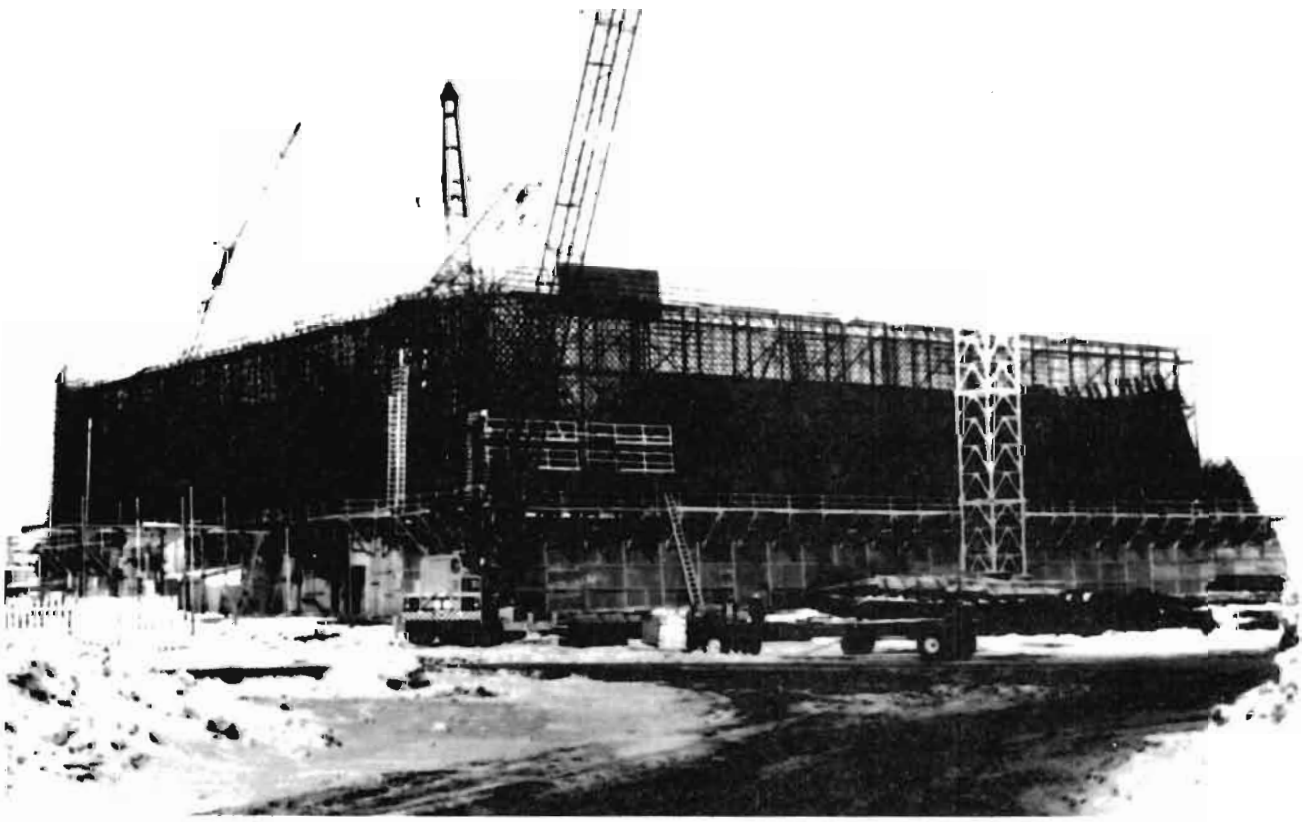
BRIGADIER GENERAL BATES C. BURNELL succeeded Major General R.P. Young as Huntsville Division Engineer effective 28 November 1970.

At the time, General Burnell assumed his new position, the unit was operating under "Modified Phase II" of SAFEGUARD announced earlier in 1970. The terms of "Modified Phase II" made ascertaining the future manpower needs of SAFEGUARD quite difficult, and the ups-and-downs experienced at Malmstrom further complicated formulation of accurate manpower estimates. Reference to actual on-board strengths, however, show that the Division continued to grow slowly after June 1970, rising from 376 civilians to 379 in September, to 402 in December, to 414 in March, and to 426 in June 1971. After mid-

1971 Division manpower stabilized at about 425 to 430 and remained at that level throughout FY 1972. The Division's Executive Office comprised twelve officers and two enlisted men in Febrauay 1971; the Executive Office at the time retained its organization as before, with Col. R.R. Wessels as Deputy Division Engineer; Col. R.W. McBride, Contracting Officer, Western Region; Col. L.W. Caffey, Contracting Officer, Eastern Region; and Col. H.K. Mattern as Contracting Officer for Procurement.[66]

Relative stability in civilian strength did not mean that the Division's organization remained static. The needs of the Division changed as the emphasis in SAFEGUARD shifted from design to construction, and this shift was reflected in the first major reorganization of the Division in June 1971. The most important change was the consolidation of the Systems Engineering Division and the Facilities Engineering Division into one Engineering Division under the direction of Lee S. Garrett, former Chief of Facilities Engineering. Additionally, an autonomous Planning and Analysis Office was established, and the Value Engineering Officer was appointed as a Special Assistant to the Division Engineer.[67]

The most spectacular testimony to the advancement of the SAFEGAURD program during 1971, however, was not to be found in budgetary or manpower figures nor in the halls and offices of Huntsville Division, but in the materialization of the Grand Forks facilities out of the North Dakota prairies. Here the 1971 construction season saw the MSR and PAR Buildings transformed from rather ugly half-finished shapes to recognizable, indeed, nearly complete, buildings enormously impressive not only for their immensity but also for their clean, simple, functional lines which now began to show through the clutter of scaffolding, scantlings, and wooden forms that still mantled them. Clustering about the main building, the auxiliary support structures also assumed clearly defined shapes as the year progressed. And viewers with a bird's eye perspective could also have seen large-scale digging and heaping of earth, evidence that subterranean structures such as the heat sinks, the water storage reserviors, and the waste stabilization ponds were taking shape. Finally, those who looked closely at the surrounding countryside at some distance would have detected the beginning of work on the four RLS sites.



GRAND FORKS WINTER CONSTRUCTION 1970-71 at the PAR site. Most work was performed inside with only essential work on the exterior.

The 1971 construction season at Grand Forks really began in earnest around mid-March as M-KA personnel began to tunnel out from under winter's snow and insulation material that had blanketed the main structures for months. The batch plants were inspected, repaired, and checked out in preparation for the resumption of concrete pours, and notices were sent out to the union halls representing the tradesmen needed for heavy structural work. Originally, concrete pouring was scheduled to begin on 15 March, but as late as 18 March snow continued to fall, accumulating in place into eight foot drifts. Under these conditions M-KA was not able to make the first concrete pour of 1971 until 30 March. After this date work accelerated rapidly at both sites, so that three weeks later, on 22 April, M-KA reported it had poured 1808 cubic yards at the MSR and 1395 at the PAR. At the time outside work resumed, M-KA had 1348 men on the job; a month later, on 29 April, this had increased to 2080.[68]

If mobilization went rapidly at Grand Forks during the spring, it did not do so without annoyances and hindrances. On 27 March, just as construction resumed, the State of North Dakota imposed its annual load limits on state highways to protect them during the thaw. State highways ND 1 and ND 5 to the MSR site were particularly affected, the contractor noting that the "restriction could reduce his 'pay load' as much as 50%."[69] The load limits were understandable and unavoidable, but a good many of the contemporary labor squabbles, disputes, and walk-offs that delayed the job were not. A homely description of one incident more severe and costly than most during the spring was recorded by the Area Office chronicler for the period 6 through 12 April. It is worth quoting at length, since the causes, course, and effects were typical of the dozens of such occurrences that popped up throughout the job.

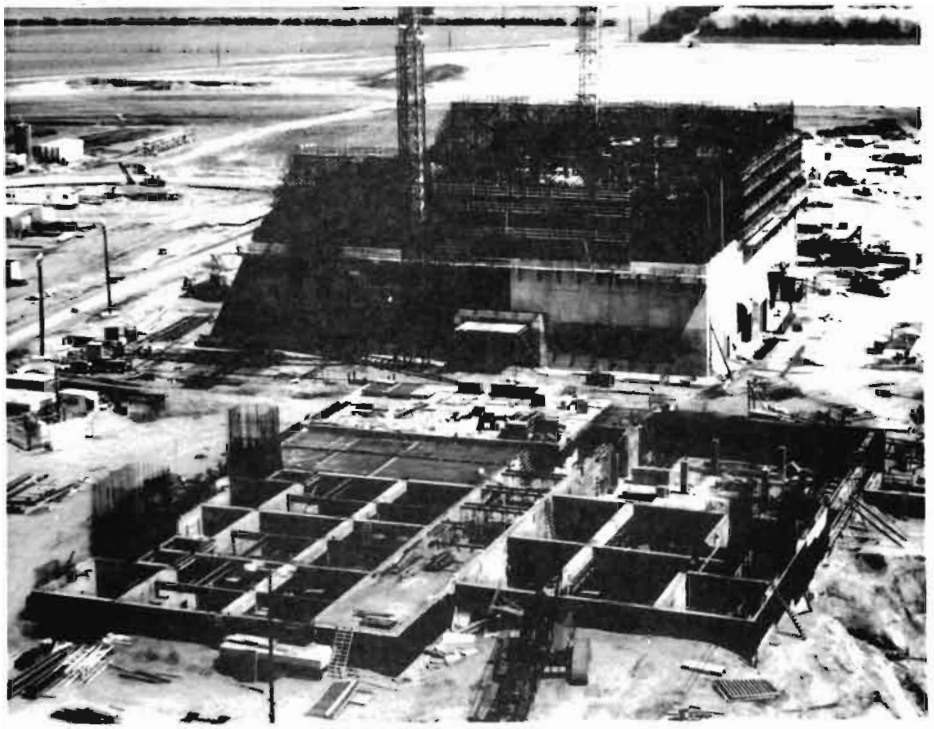
> **06 Apr 71:** MKA Ironworkers staged a brief work stoppage. Seems that three (3) of their number at PAR site left early before the lunch period, quitted the site, then returned late to their work, after lunch. Their late re-entry to the site was observed; they were questioned. Upon learning their story, MKA fired them as of 1230 hours.
>
> **07 Apr 71:** The remaining fifty-two (52) MKA iron workers reported for work at 0800 hours, but refused to commence [work] until the three (3) miscreants were re-hired. When MKA refused to yeild (sic), the former group still maintained they would not work. At 1030 hours, MKA discharged all **52** men.
>
> Concurrently, Napoleon Steel was also in difficulty with their Ironworkers; they had just fired a steward. Kent Larson, Napoleon's Project Manager, said the firm had wanted to fire this steward for some time. The Ironworkers International Representative and the Union's Local Business agent knew the steward was not performing his work properly, but asked Mr. Larson to retain him one (1) more week. If no improvement were noted at the end of that time, the steward was to be notified of such and discharged. Steward had not improved in the allotted time; he was notified and discharged at 1230 hours this day. Half of the ironworkers then went [out]; the remainder milled about the project - did no work.
>
> **08 Apr 71:** As a matter of record, MKA Ironworkers' strike was considered terminated at 1630 hours. Replacement Ironworkers had begun to appear on the job.
>
> As for Napoleon Ironworkers, the Project Manager reported about 0835 hours, to Corps Labor Relations Officer, that one of his workers had been kidnapped sometime during 07 Apr. He was threatened with bodily harm to himself and his family. The individual involved was so badly frightened that he asked not to be identified, nor would he reveal who threatened him. He was badly beaten before being released.
>
> Larson also told of one of his foremen being run off the road while the latter was in his car; his adversary threatened the foreman would be shot if the Union steward was not put back on the payroll. Larson reported both incidents to the Pembina County Sheriff.
>
> By 0930 hours, fifty-one (51) workers had returned to their work. Larson said that in order to get them there, he had to re-hire the fired steward. Until Monday, 12 Apr, at which time, the Union would have a replacement steward.
>
> It is estimated that about 45 man days were lost as a result of this strike.[70]

Finally, while spring temperatures were conducive to outdoor work, precipitation frequently was not. Rain fell on both sites throughout May, leaving the ground a quagmire of cold mud. Over an inch of rain fell during the first week in June, and on 11 June a mighty thunderstorm dumped four inches on the PAR site in less than two hours. The runoff casued flooding and severe erosion; personnel on the second shift had to limit their activity to pumping and cleaning up.[71]

The first major milestone of the 1971 season was the arrival and installation of the first diesel generator unit for Grand Forks. The Cooper-Bessemer unit departed the Oil City, Pennsylvania, factory by rail on 25 June. Since the complete item weighed 35 tons and had to be moved by truck from Hensel in part over State roads, an overload permit had to be secured from North Dakota regulatory agencies. At the Grand Forks sites, it became a matter of conjecture as to whether the State would grant such a permit until it was happy with the status of community impact and highway funds, and in fact the permission was not issued until 7 July. This eleventh hour decision fortuitously prevented any delay. The engine generator was unloaded at Hensel on 8 July, and it arrived at the PAR site on 12 July. During the last week in July, this unit was lowered through the roof of the incomplete power plant into Module 5, aligned, and anchored. The arrival of the first Cooper-Bessemer units raised the total value of GFP delivered to Grand Forks to $3,062,418.[72]

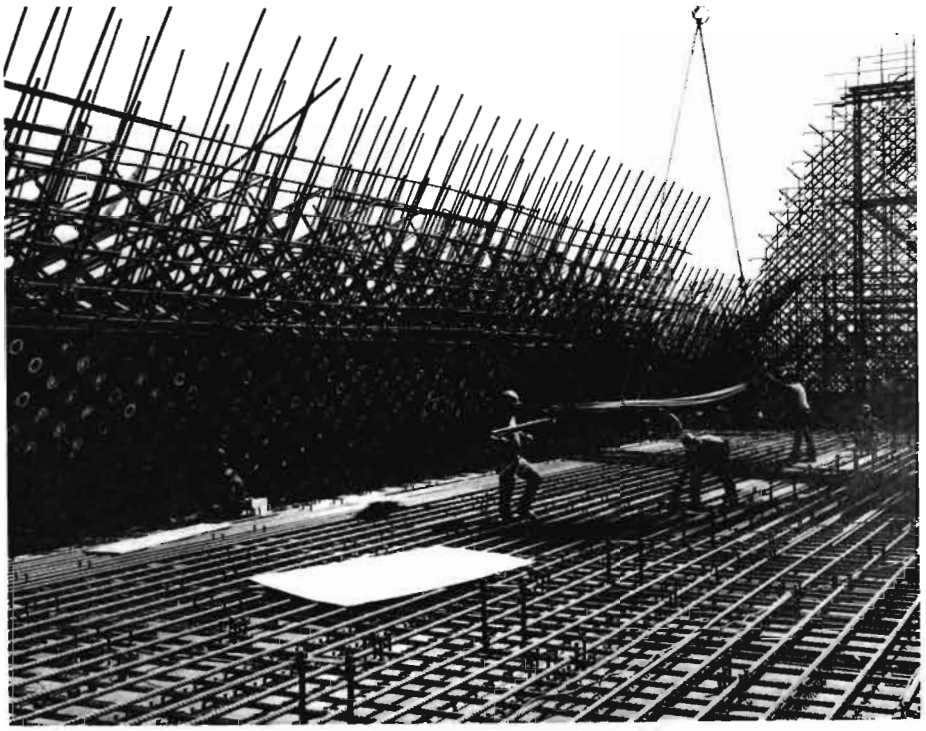
By 1 July MK-A's mobilization for the season was

THE FIRST OF THE DIESEL ENGINES AND AUXILIARIES SKID to arrive at the Grand Forks Perimeter Acquistion Radar (PAR) site from Cooper Bessemer Company, Grove City, Pennsylvania.

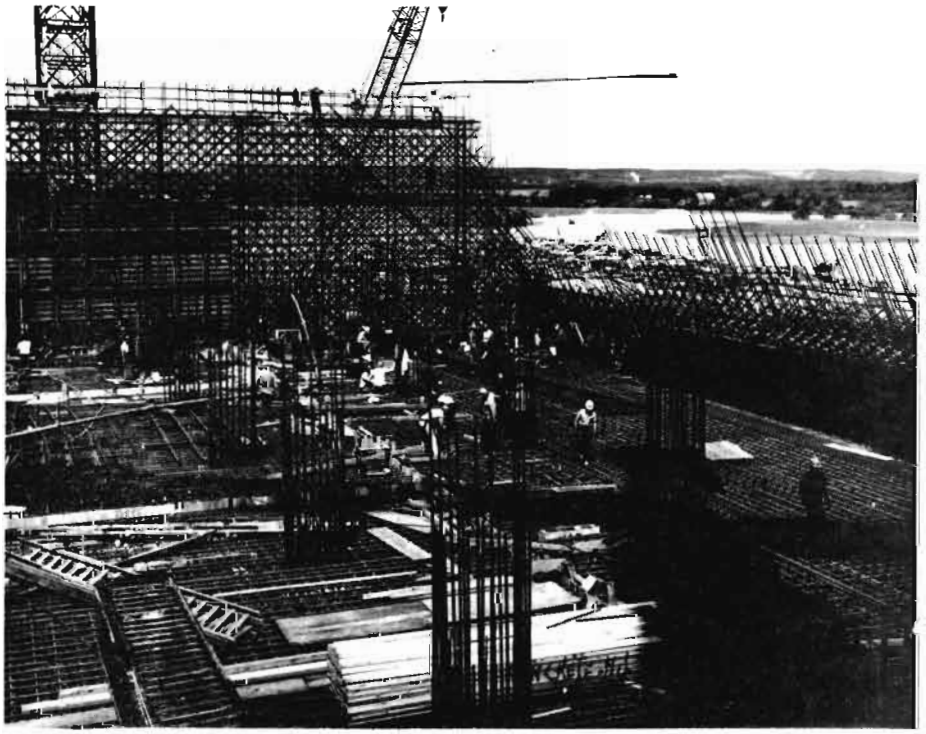


A VIEW OF THE GRAND FORKS PERIMETER ACQUISTION RADAR SITE during June 1971, looking across the top of the 14.3 megawatt power plant toward the west wall of the Perimeter Acquisition Radar Building.

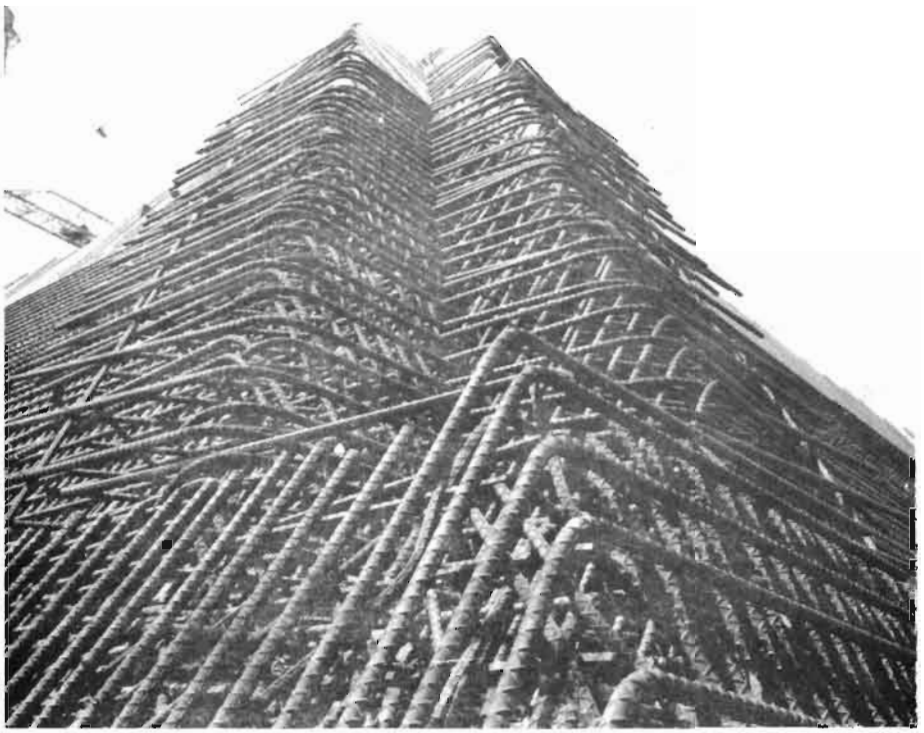
THE MISSILE SITE RADAR SITE in June 1971 during construction near Grand Forks. At left is the 7-1/2-million-gallon capacity heat sink which will be underground when completed. At right center is the 17.3 megawatt power plant with its roof being closed in. Directly behind the power plant is the Missile Site Control Building with the third floor structure being roofed in and the radar turret starting to be formed up.



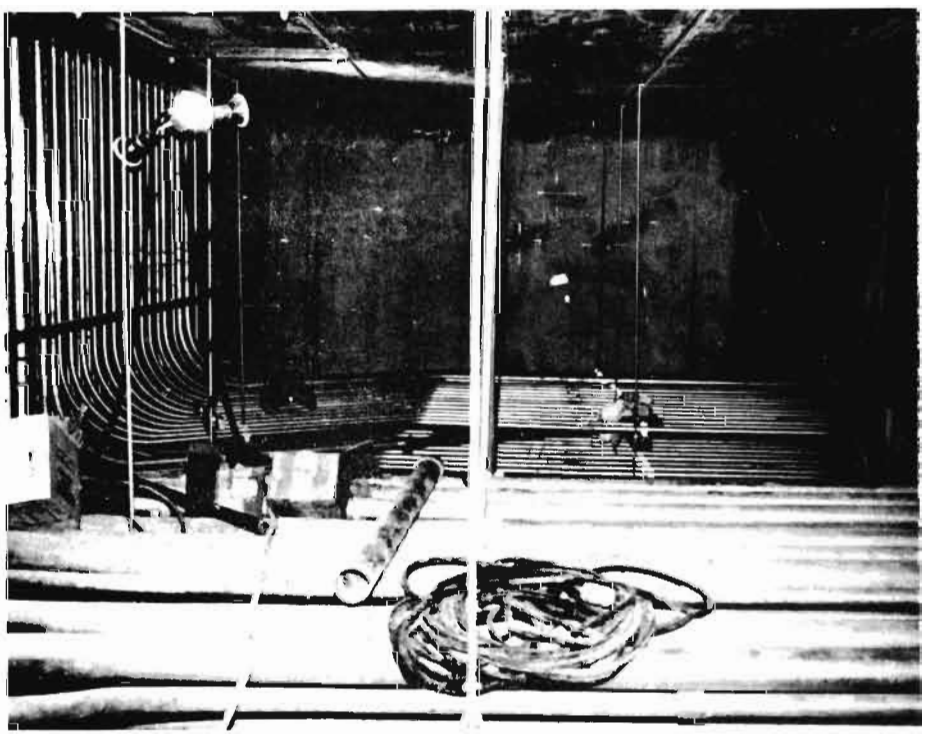
RADAR TUBE PENETRATIONS in the radar face of the PARB of the Grand Forks Safeguard complex under construction in June 1971, northeastern North Dakota.



THE THIRD FLOOR NORTHWEST CORNER OF THE PARB of the Grand Forks Safeguard complex under construction in June 1971, in northeastern North Dakota.

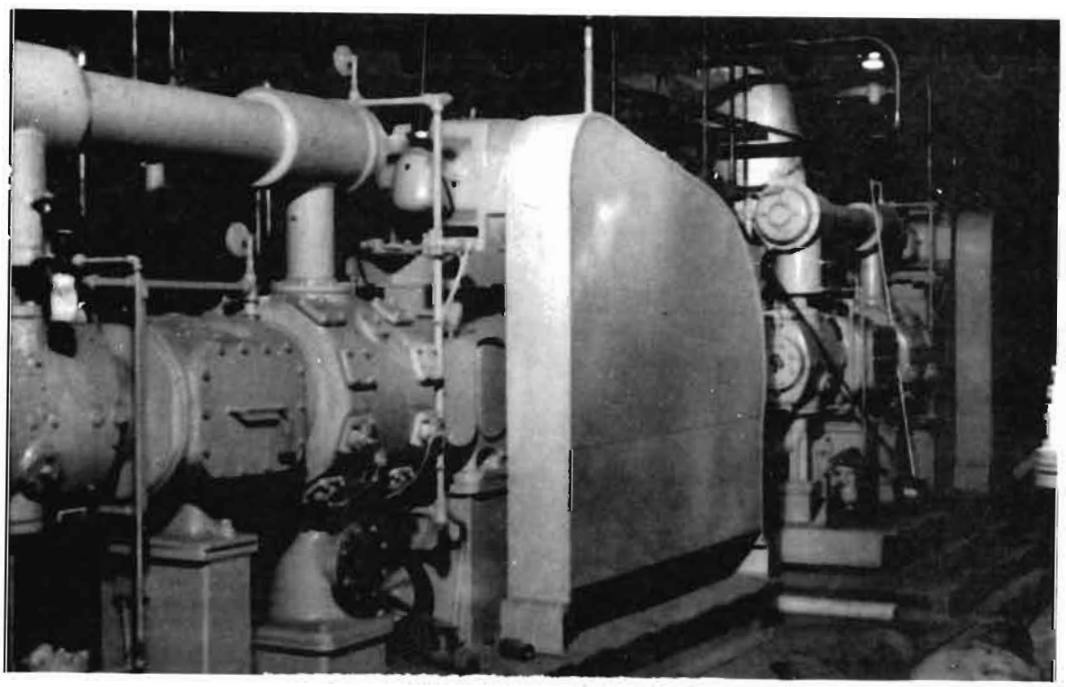


AN INTRICATE MASS OF REBAR FOR THE TURRET WALL of the nation's first Safeguard ballistic missile defense system complex at Grand Forks, North Dakota (July 1971).



MILES OF CONDUIT being, installed at the Grand Forks Safeguard BMD complex in the Missile Site Radar Power Plant during the subzero weather in January 1971.

MILES OF CONDUIT being, installed at the Grand Forks Safeguard BMD system complex in the Missile Site Radar Power Plant during the subzero weather in January 1971.



AIR HANDLING EQUIPMENT installed in the Grand Forks PARB.

GRAND FORKS PARB "A" wall showing penetration from the inside.

PERIMETER ACQUISTION RADAR SITE North Dakota Fall 1972

GRAND FORKS MISSILE SITE RADAR SITE North Dakota Fall 1972.

REMOTE SPRINT LAUNCH SITE #2 North Dakota Fall 1972.

complete, with 2,424 employees on the job. By contrast with the previous season, the workforce during 1971 was highly varied, since electricians, plumbers, sheetmetal workers, plasterers, and painters continued to work in the lower level interiors while heavy structural work went on above them. As in 1970, however, it sometimes proved difficult to recruit adequate numbers of these skilled craftsmen. The case of electricians may be cited as typical. All during the summer, M-KA had experienced a severe shortage of electricians that could not or would not be filled by local union halls. As a consequence, M-KA was permitted to implement a unique solution: Canadian craftsmen were invited to join the job and work visas were arranged for several dozen of them. Ironworkers and pipefitters were also needed, and to increase the latter's ranks, M-KA again resorted to an on-the-job training program as it had for carpenters the previous year.[73]

Whether American or Canadian, experienced or apprentice, the principal goal for all M-KA personnel during 1971 was identical: "top out" the main buildings so the installation of equipment and systems could continue through the winter months. Massive rebar and concrete placement during the summer months virtually insured that this goal would be met without the acceleration charcteristic of 1970. The MSR Building required less material in its upper portion than the PAR, and thus this building was the first radar building to be roofed in. The third level walls and fourth floor slab were in place by the third week in August, 12,883 yards of concrete having been poured since start-up. At about this stage, a potential setback developed in the guise of a delay in the shipment of the huge segmented antenna support rings which had to be placed in the turret walls before concrete pouring could be terminated. It was decided to go ahead without the rings by blocking out the spaces needed to accommodate them in the expectation that the fabrications would be delivered by mid-October at the latest. By the first week in September, the fourth level slab was complete, and the next three weeks saw the remaining walls formed and poured, complete with roof cap. In celebration of the event, a small, informal ceremony was conducted by Lt. Col. Vernon K. Davis, the Assistant Area Engineer, and a handful of M-KA personnel.[74] As a footnote, it might be added that the antenna rings expected in September arrived only the next May! The yawning round "windows" thus left gaping in the MSR turret walls were closed by temporary timber and plywood boxes during the winter months.

"Topping out" of the PAR Building followed the MSR by two weeks. The fourth floor slab and fourth level walls, with the exception of the "A-wall" face, had been poured by the first week of September, and the final placements of concrete, with exception of the parapet, were made late in October. A total of 26,824 cubic yards of concrete had been placed since start-up in March. The occasion was a momentous one for the SAFEGUARD program, and it was indicated in appropriate fashion by a "topping out" ceremony at the building conducted by Division Engineer General Burnell and officials from M-KA, including Project Manager William Gilfillan.[75] With the PAR Building roofed in, attention turned to fitting out the interior and installing tactical support equipment and systems. A full account of these activities would be tedious and unnecessary, but the reader can get a good idea of their variety and intricacy from part of a construction status report of 31 January:

> PAR Site-at the first level PARB door frames are being installed; corrugated metal wall partitions placed; deionized water, chilled water, and pump discharge lines are being installed; shock isolation platforms are being placed; and wire being pulled from the switchgear to the motor control panels and power panels. On the second level, corrugated metal wall partitions, panels, and liner plates are being installed; heating, and deionized water, and nitrogen lines laid; pull boxes, receptable switches and permanent lighting fixtures installed; RFI filters and conduit are being installed; and wire pulling continued. . . .On the fifth level, welding of ceiling liner plates accomplished; concrete columns finished; phase shifter steel supports erected; chilled water and waterlines installed; and welding of the front face liner plate to the penetration tubes accomplished.[76]

Roofing in of the power plants for both the PAR and MSR had been completed some days before the radar buildings. Work on the power plants had gone forward despite a 19 day strike that occurred at the Cooper-Bessemer plant in Pennsylvania after 31 August. At that time, one engine was undergoing assembly testing, one was ready for assembly tests, one was being factory tested, and one was ready for factory testing. Cooper-Bessemer employees returned to work on 20 September, and shipment of units resumed soon thereafter. By 30 September the PAR Power Plant had received three engine generators, and the last of the five required was on-site. At the same date, three

engine-generators were on the MSR site, one at Hensel, and one in transit from Cooper-Bessemer. All of these units were in place at the PAR Power Plant and four out of five at the MSR Power Plant by 1 December. Simultaneous with the installation of the engine-generators, the tunnels linking the power plants with the radar buildings were closed in and the intricate installation of miles of wire, conduit, pipe, and ducting for various systems went on during the winter.[77]

In addition to the advancement of the main structures at Grand Forks, 1971 also saw the award and initiation of construction for several smaller, but nonetheless essential, elements of the facilities. Under the "Modified Phase II", of SAFEGUARD, it had been decided to increase the number of RLS's at each site from two to four, each equipped with from twelve to sixteen SPRINT's and a small hardened Remote Launch Operations Building (RLOB). A contract for the construction of RSL's 2 and 3 at Grand Forks in the amount of $7,630,950. was awarded to a joint venture sponsored by Woerfel Corporation & Towne Realty, Inc., on 26 March 1971. By the end of the construction season, Woerfel & Towne had set all prefabricated steel SPRINT cells in place, completed the RLOB structures, and were fitting out the interior of the buildings during the winter months. RLS's Nos. 1 and 4 were about six months behind Nos. 2 and 3, a contract for their construction being awarded to Woerfel Corporation & Towne Realty, Inc., for $7,870,533.00 on 26 August 1971. Only the site grading, fencing, preliminary stripping, and other preparatory work under this contract had been completed by the close of the season in November.

Neither the PAR nor the MSR nor the RLS's could have been operated on a twenty-four hour, day-in and day-out basis without extensive facilities for the several hundred men who operated and kept up the radars and missiles. These military personnel required administrative office space, housing, food services, medical care, classroom and maintenance facilities, a chapel, and recreational opportunities; provision for most of these "Non-technical Support Facilities" was contained in a single contract that was awarded to Chris Berg, Inc.,on 6 April 1971. The contract was in the amount of $7,728,237.00, with completion due by December 1972. A separate $854,420.00 contract for a gymasium at the PAR was awarded to Chris Berg, Inc. gymasium at the PAR was awarded to Chris Berg, Inc., in May 1972. All of these structures were of conventional of "soft" construction expendable in case of attack, and neither their design nor their erection during 1971 offered any noteworthy features.[78]

As 1971 came to a close, the SAFEGUARD infrastructure as a whole could reflect on a successful start-up with the Grand Forks construction and its timely progress. If Malmstrom had been delayed, it was not because of deficiencies in its design or construction but rather to broad socio-economic forces at work everywhere. A solution to the Malmstrom difficulties seemed in hand by December, and the spring of 1972 promised that this site, too , could be developed with as much success as Grand Forks. But beyond the realm of construction, the passage of time was also showing that once completed, the SAFEGUARD facilities would, in fact, offer a workable ABM defense for the nation's deterrent forces. In a Pacific test on 23 December 1970, the SPRINT achieved successful interception of a "live" target fired from Vanderburg AFB, California, the SPARTAN having accomplished the same type intercept earlier in 1970. By this time, both SPARTAN and SPRINT were fully integrated with the prototype MSR computer and software on Meck Island, demonstrating that the system would function as a harmonious whole. No operational prototype of the PAR had been built or tested, but there was reason to believe that it, too, would perform as well as the other parts of the system. In summary, by the spring of 1972 the SAFEGUARD program was alive, well, and on schedule. But at the same time, far from Huntsville or North Dakota, the SALT talks were proceeding through crucial issues towards a final agreement limiting ABM systems. The effects of the conclusion of these talks in 1972 would be great, as will soon be seen.

CHAPTER III FOOTNOTES

[1]The ceremonies surrounding ground-breaking were deliberately kept on a low key to avoid attracting undue public attention to the SAFEGUARD program. See the report with pictures in the **Grand Forks Hearld**, 7 April 1970, p. 1.

[2]USAEDH-PAO, "Historical Summary, FY 1970," I, Narrative, p.1, and "History Summary FY 1971," I, Narrative, pp. 19-20.

[3]USAEDH-PAO, "Historical Summary FY 1970," I, Narrative, pp. 28-32; USAEDH-GF "History of the Grand Forks Area Office," n.p., n.d., Pt.I, FY 1970, pp. 7-8. The "History of the Grand Forks Area Office" is a looseleaf typescript chronicle of approximately 452 pages (some odd pagination is evident) concerning the activities of the Grand Forks SAFEGUARD Area Office from its opening on 4 November 1969 to its closure on 27 June 1975. The history is organized in three parts: Part I, construction of the technical facilities by Morrison-Knudsen & Associates; Part II, construction of the Non-technical Support Facilities by Chris Berg, Inc.; Part III, construction of the Remote Launch Sites by Woerfel Corporation & Towne Realty, Inc. Within each part there are day-by-day entries for each day that the Area Office was open. These entries observe construction progress, milestones, labor problems, accidents, changes in personnel, managerial and administrative actions, and human interest notes, to mention but a few subjects. The manuscript was complied by Jean T. Bailey, Program Analyst, Networks and Reports Branch, Contract Management Division of the Grand Forks Area Office from official weekly progress reports, correspondence, newspaper articles, and in-house contact with the Area Office staff. Though sometimes informal and lacking synthesis or analysis, the "History of the Grand Forks Area Office" represents a veritable goldmine of information about the activities at the Grand Forks sites during their construction phase. The example used in compiling this history is held by the Executive Office, Huntsville Division.

[4]USAEDH-GF, "History of the Grand Forks Office," Pt. I, FY 1970, p. 8.

[5]See the Fargo, North Dakota, **Forum,** 19 April 1970, and the **Grand Forks Hearld**, 21 April 1970, p. 11, 2nd section.

[6]**Grand Forks Herald,** 3 May 1970.

[7]The "Chicago Seven" were David T. Dellinger, age 53; Rennard C. Davis, 28; Thomas C. Hayden, 29; Abbie Hoffman, 32; Jerry C. Rubin, 30; Lee Weinar, 29; and John R. Froines, 29. These idividuals were indicted on 20 March 1969 for various charges of conspiracy to incite acts of violence and other offenses in connection with disorders that occured at the 1968 Democratic Party national convention in Chicago, Illinois. The "Chicago Seven" were tried between 24 September 1969 and 14 February 1970. On 18 February 1970 all seven were acquitted of conspiracy to incite riot, but five were found guilty of crossing state lines with intent to incite a riot and giving inflammatory speeches to that end. Froines and Weinar were acquitted on both counts. The "Seven" appealed, and on 28 February 1970 they were released by the U.S. Federal Appeals Court on bail. There their case stood in April 1970.

[8]USAEDH-OC, "History of the Office of Counsel," Ex. 120. briefing for the Area Engineer, "Anti-ABM Day, 16 May," n.d.

[9]USAEDH-OC, "History of the Office of Counsel," Ex. 119, letter of Col. Bates C. Burnell, Deputy Division Engineer, to Col. Roy Beatty, Area Engineer, on 16 May 1970, concerning "Construction Site Security." Para. 4 of this letter summarizes the Government and Corps position nicely: "The guidance in this letter is based upon the concept that the Government and the contractor are pursuing a lawful and peaceful activity on Government owned or controlled property and that others, who may be exercising their lawful right to assemble and demonstrate, do not have the right to interfere or obstruct our activities. The objective is to continue construction operations as planned to the fullest extent possible. However, in pursuing this objective we would not use force and would take those actions which avoid verbal exchange or physical contact and which reduce the possibility of escalating incipient violence. We recognize that the local and state law enforcement agencies are responsible for maintaining order and we will cooperate with those agencies to the fullest extent."

[10]USAEDH—PAO, "Historical Summary FY 1970," I, Narrative, p. 35; USAEDH-GF, "History of the Grand Forks Office," Pt. I, FY 1970, pp. 8-9. In addition to the usual documents, I have been greatly assisted by the personal recollections of Geroge G. Stewart, Public Affairs Officer and Historian of the Huntsville Division, delivered in the course of several conversations during the spring of 1977.

[11]I have used the Corps of Engineers estimate of attendance recorded in the Division's "Historical Summary FY 1970," I, Narrative, pp. 35-36. The attendance figures reported for the demonstrations varied widely, reflecting both the usual human error and the hopes, fears, biases, or attitudes of those making the estimates. The figures recorded by the USAEDH-GF. "History of the Grand Forks Office," Pt. I, FY 1970, pp. 10-11, agree with the Corps estimate of 500 persons. The API news report in the **St. Paul Pioneer Press,** 17 May 1970, reported "nearly" 1,500" persons at the demonstration. The **Washington Post,** 17 May 1970, reported "from 900 to 1,200." The **Boston Globe** for Sunday, 17 May, had a special report by Chuck Haga which gave an estimated crowd of "More than 1000." Some of the accuracy of these figures may be judged by the fact that Haga also reported to the **Boston Globe** that the excavation of the MSR was a "60-foot deep hole," whereas in fact it was probaby no more than forty to fifty feet deep.

[12]**Grand Forks Herald,** 17 May 1970.

[13]API report in the **St. Paul Pioneer Press,** 17 May 1970.

[14]**Washington Post,** 17 May 1970.

[15]USAEDH-PAO, "Historical Summary FY 1970," I, Narrative, pp. 35-36; USAEDH-GF, "History of the Grand Forks Office," Pt. I, FY 1970, p.11.

[16]The estimate of $1,000 damage is from the "Historical Summary FY 1970," I, Narrative, p. 36. See also the similar remarks in USAEDH-GF, "History of the Grand Forks Office," Pt. I, FY 1970, p. 11. Neither **Time** nor **Newsweek** nor the **New York Times** took any notice of the Grand Forks demonstration.

[17]William Beecher, "Laird Says Soviet Speeds Up Threat," **New York Times,** 8 January 1970.

[18]Adams, **Ballistic Missile Defense,** p. 225.

[19]See William Beecher, "White House Debates Whether to Expand ABM in Budget Due in January," **New York Times,** 21 December 1969. Beecher indicated that the annual review was being made in the Defense Program Review Committee comprised of Henry Kissinger, David Packard, Eliot Richardson (Undersecretary of State), Robert P. Mayo (Director of Bureau of the Budget), Paul W. McCracken (Chairman of the Council of Economic Advisors), and General Earle G. Wheeler (Chief of Staff, Joint Chiefs of Staff).

[20]"Transcript of the President's News Conference on Foreign and Domestic Matters," **New York Times** 31 January 1970, p. 14.

[21]William Beecher, "Expansion of ABM to 3rd Missile Site is Sought By Laird," **New York Times,** Wednesday, 25 February 1970, p. 1; USAEDH-PAO, "Information Bulletin," III, No. 5 (13 Mar. 1970), pp. 1-3; Adams, **Ballistic Missile Defense,** pp. 224-225.

[22]Adams, **Ballistic Missile Defense,** pp. 226-230.

[23]USAEDH-PAO, "Historical Summary FY 1971," I, Narrative, p. 11.

[24]See, for example, the **Great Falls Tribune** for 22-30 October 1969.

[25]USADEH-PAO, "Information Bulletin," V, No. 10 (16 Oct. 1972), pp. 2-3.

[26]USAEDH-PAO, "Historical Summary FY 1970," II, Documents, p. 117; USAEDH-PAO, "Historical Summary FY 1970," I, Narrative, 31.

[27]USAEDH-PAO, "Historical Summary FY 1970," I, Narrative, p. 32; USAEDH-PAO, "Historical Summary FY 1970," II, Documents, pp. 89-91; USAEDH-PAO, "Information Bulletin," III, No. 22 (13 Nov. 1970), p. 2.

[28]U.S. Army Engr. Dist. OMAHA, "U.S. Army SAFEGUARD System Command Community Impact Report Malmstrom Deployment Area," July 1970.

[29]The transcript of Governor Anderson's testimony before the Senate is reproduced in full in the Conrad, Montana, **Independent-Observer,** 20 August 1970. The concern and controversy over the impact of SAFEGUARD in the locality can be followed in the **Great Fall Tribune** and the Conrad **Independent-Observer** after March 1970.

[30]A fact sheet prepared on 1 September 1971 by the Office of Counsel, USAEDH, is essential in tracing the intricate development of the labor problem in Montana. It includes a list of thirty-eight documents or correspondence at all levels between parties in the dispute. USAEDH -OC , "History of the Office of Counsel," Ex. 274, Fact Sheet: "Labor Problems Experienced by Huntsville Division, U.S. Army Corps of Engineers on the SAFEGUARD Project in Montana" 1 September 1971.

[31]USAEDH-OC, "History of the Office of Counsel," Ex. 171, Trip Report of Stephen V. Rohr on visit to Great Falls, Montana, 26-29 April 1970.

[32]Ibid.; USAEDH-OC, "History of the Office of Counsel," Ex. 171, Memorandum for Record, "SAFSO Query on Potential Labor Problems at the Malmstrom SAFEGUARD Sites," 28 May 1970.

[33]USAEDH-OC, "History of the Office of Counsel," Ex. 171, letter of Division Engineer General Young to Chief of Engineers, "Potential Labor Problems at the Malmstrom SAFEGUARD Sites," 20 May 1970.

[34]This was contract DACA87-70-C-0017. The bid opening was held at the Rainbow Hotel, Great Falls, Montana, at 11:00 AM on 30 April 1970, with seven bids being offered. USAEDH-PAO, "Historical Summary FY 1970," II, Documents, p. 35.

[35]This is contract DACA87-70-C-0020. The bid opening was conducted at the Rainbow Hotel, Great Falls, Montana, at 11:00 AM on 14 May 1970, with six bids being received. USAEDH-PAO, "Historical Summary FY 1970," II, Documents, p. 36.

[36]USAEDH-PAO, "Historical Summary FY 1971," I, Narrative, p. 34, at the date of 2 September 1970.

[37]USAEDH -GF , "History of the Grand Forks Office," Pt. I, FY 1971, pp. 20-21.

[38]USADEH-PAO, "Information Bulletin," III, No. 16 (21 Aug. 1970), p.1.

[39]USAEDH-PAO, "Historical Summary FY 1971," I, Narrative, pp. 42-44.

[40]USAEDH-GF, "History of the Grand Forks Office," Pt. I, FY 1970, p. 13.

[41]Ibid., 16.

[42]Ibid., pp. 42-43, 55; USAEDH-PAO, "Historical Summary FY 1971," I, Narrative, p. 79; USAEDH-PAO, "Historical Summary FY 1972," I, Narrative, p. 29.

[43]USAEDH-GF, "History of the Grand Forks Office," Pt. I, FY 1971, p. 23.

[44]Ibid., pp. 21-23.

[45]Ibid., p. 24.

[46]Ibid., pp. 27-28; The original of this letter is on file in the Office of Counsel under "Correspondence: Grand Forks."

[47]The accelerated phase actually ended on 27 November 1970. Memorandum for the Division Engineer from Col. Robert W. McBride, Assistant Division Engineer for the Western Region, dated 20 November 1970, on file in the Office of Counsel under "Correspondence: Grand Forks."

[48]Ibid.

[49]USAEDH-PAO, "Information Bulletin," IV, No. 2 (29 Jan 1971), p.4.

[50]Ibid., pp. 1-4.

[51]USAEDH-GF, "History of the Grand Forks Office," Pt. I, FY 1971, pp. 26-39; USAEDH-PAO, "Historical Summary FY 1971," I, Narrative, pp. 42-69.

[52]USAEDH-PAO, "Information Bulletin," IV, No. 1 (15 Jan. 1971), p.2.

[53]USAEDH-PAO, "Information Bulletin," IV, No. 5 (12 Mar. 1971), pp. 1-3; USAEDH-PAO, "Command Information Fact Sheet for Employees," CI-4 (Jan. 1971).

[54]USAEDH-OC, "History of the Office of Counsel," Ex. 115, legal opinion delivered to Assistant Division Engineer for Western Region Col. Robert McBride by Huntsville Division Counsel Emil Vuch entitled "Packaging of Malmstrom Construction," 20 April 1970; USAEDH-PAO, "Information Bulletin," III, No. 14 (24 July 1970), p. 1.

[55]USAEDH -PAO, "Information Bulletin," IV, No. 1 (15 Jan. 1971), p. 4.

[56]USAEDH-OC, "History of the Office of Counsel," Supp. 4 (Oct. 1970 - Oct. 1971), p. 34; USAEDH-PAO, "Information Bulletin," V, No. 19 (15 Dec. 1971), pp. 3-4.

[57]USAEDH-OC, "History of the Office of Counsel," Ex. 271, letter of Hon. Stanley R. Resor, Secretary of the Army, to Curtis Counts, Director of FMCS, 1 March 1971.

[58]Ibid.

[59]USAEDH-OC, "History of the Office of Counsel," Ex. 360, letter of Division Engineer General Bates C. Burnell to Headquarters, Department of the Army, "Project Stabilization Agreement for the Malmstrom SAFEGUARD Ballistic Missile Defense System (BMDS) Project, Conrad, Montana." 18 February 1972; USAEDH-PAO, "Information Bulletin," IV, No. 19 (15 Dec. 1971), pp. 3-4.

[60]USAEDH-PAO, "Information Bulletin," IV, No. 19 (15 Dec. 1971), pp. 3-4; USAEDH-PAO, "Historical Summary FY 1972," I, Narrative, pp. 89-90.

[61]USAEDH-PAO, "Historical Summary FY 1972," I, Narrative, p. 124.

[62]USAEDH-PAO, "Information Bulletin," VI, No. 2 (3 Mar. 1972), pp. 1-2.

[63]Malmstrom RLS's 2 and 3 were awarded under contract DACA87-72-C-0060 to a joint venture sponsored by H.C. Smith Construction Company, Compton, California, for $8,835,298.00. The Malmstrom Non-technical Support Facilities were awarded to Chris Berg, Inc., of Seattle, Washington, for $10,717,000 under contract DACA87-72-C-0066. Malmstrom RLS's 1 and 4 were awarded to a joint venture sponsored by H.C. Smith for $8,896,491.00 under contract DACA87-72-C-0072.

[64]USAEDH-PAO, "Historical Summary FY 1972," I, Narrative, p. 6.

[65]USAEDH-PAO, "Information Bulletin," III, No. 21 (30 Oct. 1970), p. 1, and III, No. 23 (4 Dec. 1970), p. 1.

[66]USAEDH-PAO, "Historical Summary FY 1971," I, Narrative, pp. 1-5, and "Historical Summary FY 1972," I, Narrative, pp. 1-2.

[67]USAEDH-PAO, "Historical Summary FY 1971," I, Narrative, p. 113; USAEDH-PAO, "Information Bulletin," IV, No. 12 (25 June 1971), p. 1.

[68]USAEDH-GF, "History of the Grand Forks Office," Pt. I, FY 1971, pp. 45-50.

[69]Ibid., p. 47.

[70]Ibid., pp. 48-49.

[71]Ibid., pp. 52, 55.

[72]Ibid., pp. 59, 63; USAEDH-PAO, "Historical Summary FY 1972," I, Narrative, p. 15.

[73]USAEDH-GF, "History of the Grand Forks Office," Pt. I, FY 1971, pp. 57, 65-73.

[74]Ibid., p. 74.

[75]Ibid., p. 76; USAEDH-PAO, "Information Bulletin," IV, No. 18 (19 Nov. 1971), pp. 1-2.

[76]USAEDH-PAO, "Historical Summary FY 1972," I, Narrative, pp. 110-111.

[77]Ibid., pp. 53-54, 80-81.

[78]The main contract for Non-technical Support Facilities at Grand Forks was DACA87-71-C-0054; the contract for a gymnasium was DACA87-72-C-0074.

CHAPTER IV

SALT AND AFTER

As has been seen in Chapters II and III, the years 1970 and 1971 were years of advancement for the SAFEGUARD System. During these years Congress showed itself willing to endorse at least a modified version of ABM comprising four sites, and the Corps of Engineers had made substantial progress towards making the initial deployment at Grand Forks and Malmstrom AFB's a reality. In 1970 and 1971, too, the weapons system's hardware and software were proven workable through extensive laboratory and field testing. Technically, politically, and militarily the SAFEGUARD System was achieving both wider acceptance and verified performance as its deployment proceeded. Just as SAFEGUARD grew into maturity, however, disarmament discussions were inaugurated between the U.S. and the USSR with the objective of clamping a lid on the arms race. One of the biggest issues at these Strategic Arms Limitation Talks, or SALT, sessions was the question of limiting or terminating ABM development and deployment.

In the years since the SENTINEL System's inception in 1967, the need for some kind of armaments limitation had become ever plainer, primarily because of U.S.-Soviet rivalry. Though the Soviet Union had generally been rather cautious in undertaking adventurous foreign involvements, it had also clearly clung to a commitment of world domination by offering military equipment, technical advisers, and moral support to its friends in the Warsaw Pact countries, to the Arab states, and in Southeast Asia. The Czechoslovakian invasion of 1968 also demonstrated Soviet determination to keep its satellites within the fold of communist orthodoxy. Moreover, the Soviets had continued to build up their strategic arsenal beyond the needs of mere self-defense, apparently striving for superiority rather than nuclear parity with the U.S. By 1972 the USSR possessed about 280 huge SS-9 missiles with multiple, but not year independently targeted, multi- megaton warheads roughly equivalent to the American TITAN II or MINUTEMAN III, along with greater numbers of smaller or older ICBM's. The Soviets also started about fifty or sixty new launching silos in the twenty-one months after August 1969, the latest of which seemed to be a modified design to accommodate a missile even larger than SS-9. In the winter of 1971, after SALT began, some observers detected a slowdown in silo construction attributable to good intentions of agreement on limitation, but other experts ascribed the slowing to a decision to retroactively harden SS-9 silos to a degree comparable with MINUTEMAN's. Finally, by 1971 the Soviet Union had completed an ABM system called GALOSH around Moscow with about sixty-four interceptor missiles, but no further sites had been started.

While the Soviet threat thus became more menacing after 1967, the threat from Communist China became less ominous with the passage of time. During the late 1960's it had commonly been asserted that the Chinese were on the road to becoming a great nuclear power and that they might very well flex their new-found muscle in irrational ways such as a preemptive strike. By the early 1970's, however, a reassessment of these views was in order. Certainly, Chinese technological and military capabilities continued to mature, but the pace of their growth was proving to be considerably less rapid than previously thought and no aberrant behavior had materialized. Even more significantly, the sabre-rattling emanating from Peking became less vociferous as the "Cultural Revolution" receded into the past. A further sign of thawing relations with the West was President Nixon's unprecedented week-long visit to China in February 1972.

The changing complexion of international, technological, and military affairs in the early 1970's made some kind of American-Soviet discussions about limiting strategic arms more desirable than ever, while Chinese participation was still unlikely. Overtures for initiation of arms talks between the two superpowers had been exchanged since before the signing of the Nuclear Non-Proliferation Treaty on 1 July 1968, but any conference had subsequently been thwarted by the Vietnam War, Presidental elections, the Czech invasion, and similar perturbations. Thus, the preliminaries to the SALT talks did not get underway in Helsinki, Finland, until 19 November 1969, and the first substantive proposals were not made until the talks resumed in Vienna on 16 April 1970. The first SAFEGUARD site at Grand Forks was then just underway.

More than two years of toe-to-toe negotiations at Vienna and Helsinki were necessary to iron out a bilateral agreement on major elements in a limitation treaty, but in the spring of 1972 a basic concurrence was finally achieved. On Friday, 26 May, in Moscow, President Nixon and First Secretary Leonid Brezhnev formally signed the "Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile

Systems."[1] According to the terms of the brief ten-page document, each side was limited to the deployment of two ABM sites, one within a radius of 150 kilometers of the national capital, the other within an ICBM deployment area radius of 150 kilometers. At each site the party could have two large phased-array radars or no more than eighteen smaller ABM radars (six at the capital site) and less than 100 interceptor missiles. In effect, these provisions recognized the different deployment directions taken by SAFEGUARD and the Soviet GALOSH and allowed the signatories to match each other if they chose to. Article IV excepted ABM systems or components used for development or testing and test ranges, and Article V applied the Treaty to sea-based, air-based, space-based, or mobile land-based systems. Article XIII called for establishment of a "Standing Consultative Commission" to consider questions of interpretation, implementation, and the exchange of information. Subparagraph (e) provided that this Commission would also "agree upon procedures and dates for destruction or dismantling of ABM Systems or their components in cases provided for by the provisions of this Treaty." Article XVI provided that the Treaty would be a "unlimited duration." Finally, on the same day, 26 May 1972, the U.S. and the Soviet Union also signed a separate agreement limiting offensive strategic weapons.

The ABM Treaty was of immense consequence for SAFEGUARD, and its effects were felt immediately after the Moscow ceremonies. The Treaty permitted only one ABM site located within American MINUTEMAN fields, so on 27 May 1972 the Secretary of Defense directed a suspension of all SAFEGUARD construction at Malmstrom and all future work at other sites except Grand Forks.[2] But a permanent termination of contracts, dismantling or destruction of extraneous sites, and reorientation of the program could not take place until the Senate ratified the Treaty, and this took four months. The Senate approved the ABM Treaty by a vote of 88-2 on 2 August, but it bogged down on the companion treaty limiting offensive nuclear weapons. This in turn delayed appointment of members to the U.S.-Soviet Standing Consultative Commission necessary to preside over site disposal. The two pacts were not finally ratified and signed by the leaders of both countries until 3 October 1972.[3]

While the resolutions of ratification for the two arms treaties were debated in the Senate during the summer, the Congress as a whole proceeded to drastically prune the SAFEGUARD program to the one site at Grand Forks that was then about 85 percent complete. On 19 August a joint committee of the House and Senate agreed on a military procurement authorization bill that eliminated any funding for construction of the second permissible SAFEGUARD site near Washington, D.C. This action did not preclude the possibility that the Administration could ask for Washington site funding the next year, or the next, but in fact this did not happen. The signing and ratification of the ABM Treaty actually meant the reduction of SAFEGUARD to completion of the North Dakota site, termination of the Montana site, and cessation of preliminary work at Whiteman AFB.

When the ABM Treaty was signed in Moscow on 26 May 1972, the Malmstrom SAFEGUARD sites were about 10 percent complete. It will be recalled that labor disputes had delayed the initiation of Phase II construction until November 1971, when a joint venture headed by Peter Kiewit Sons' Co. was awarded a 90-day letter contract with limited spending authorization. PKS&A began start-up immediately, but relatively little was accomplished during the dead of winter except preparation for what lay ahead. The PKS&A letter contract was turned into a regular contract for $160,927,922 on 24 February 1972, and construction activities began to accelerate after this time as warmer weather returned. At the end of February, grading and leveling of the contractor's office complex area was complete and twenty-seven office units had been moved on-site. The foundations had been poured for the contractor's warehouse, motor shop, maintenance shop, and change house, while the carpenter and liner plate buildings were finished. By this time, too, the Phase I batch plants had been dismantled and foundations for the new batch plants were underway.[4]

Three months later, when the Defense Department teletyped a suspension to all Malmstrom activities as of 27 May, mobilization had essentially been completed and actual construction had just gotten underway. At the PAR site all utilities were functioning and the concrete batch plant was completed. Forms, reinforcing steel, and concrete were being placed in the first level interior and exterior walls of the PAR Power Plant, while one concrete placement had been made on an exterior second level wall of the PAR Building. At the MSR site, the level of mobilization and start-up was about the same. All utility lines were in and functioning, the batch plant was running satisfactorily, and the contractor's workshops had been completed, but only a small amount of concrete had been poured in the MSR Building and its power plant. Marginally more progress had taken place in the SPARTAN and

SPRINT excavations, where twenty-four of the thirty SPARTAN launch shafts had been augered and one deflector can placed. Malmstrom RLS's 2 and 3 had just been started, while the Notice to Proceed was not issued for RLS's 1 and 4. At the time of suspension, all twenty-one miles of the Malmstrom waterline were completed, and water from Tiber Reservoir was flowing to all three sites.[5]

THE PAR SITE near Conrad, Montana, as it appeared in March 1972.

The winding-down and termination of large, complicated contracts like those at Malmstrom were operations fraught with almost as much complexity as their initial formulation and issuance. There were not only contractors but subcontractors and suppliers down to the fourth or fifth level to be dealt with, multiple claims to be settled, and sometimes considerable legal tangles to be uraveled by the Office of Counsel. In the case of Malmstrom, too, there was for a time the slim possibility that the ABM Treaty might not survive Senate examination to further confuse proper procedure. These factors bedeviled all aspects of SAFEGUARD contracting, but they especially played hob with the long-range planning required in the SAFEGUARD GFP procurement program where many multi-site, long-lead items had been contracted for delivery over a period of years.

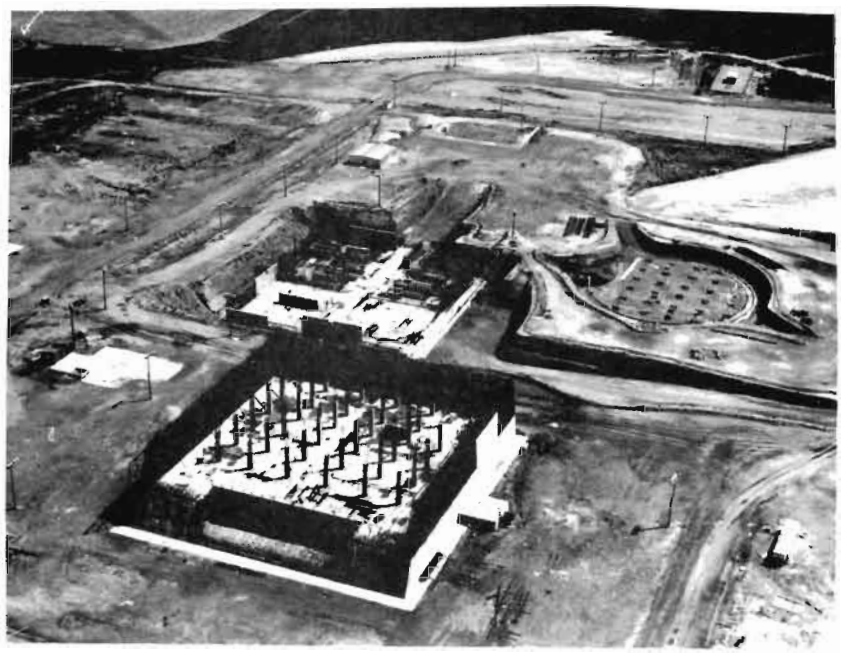
The lengthy process of settlement with contractors began immediately after the 26 May Treaty signing. Although the Department of Defense termed the cessation a "suspension of work," the probabilities seemed great that the Malmstrom job would not be resumed, so special arrangements had to be made expeditiously to reduce standby costs to the minimum while preserving a work-resumption option should it be needed. Upon receipt of message notification from the Department of Defense, telephone calls went out on extremely short notice to Procurement and Supply Division personnel to report for work on Saturday, 27 May, and Sunday, 28 May. That was a hectic weekend in the Procurement and Supply Division, since employees had to review about fifty-six contracts, determine the propriety of issuing Government "Delay of Work" notices for each contract, and prepare and issue the notices. About twenty contracts required notification of the contractor, and in the interests of time, a large majority of the notices were issued on Sunday, 28 May. For each contract involved, the contracting officer issued a formal communication to the contractor advising him to stop work on the contract in view of the ratification of the SALT Treaty, pending further instructions from the contracting officer.[6] This sudden change in direction of the GFP program was further complicated by the refusal of at least one manufacturer to honor the Delay of Work notice. Instead, he requested a termination for convenience. By regulation, terminations in excess of $25,000 required approval from OCE, and in this case expedient action was demanded to obtain OCE approval and to issue the requisite termination notice.[7]

A meeting to advise contractors of special interim procedures was held at Malmstrom on 22-23 June 1972. Here it was laid down that all subcontracts and purchase orders were to be fully terminated; plant visitation to this effect was to commence the week of 26 June; all settlements would be on a total cost basis and fully audited as required; and settlement proposals should consider work done, changes, suspension, termination, and claims, if any. Profit, interest, bid costs, and standby equipment costs were also discussed. In general, the sites themselves were to be securely mothballed with minimum expense until final disposition.[8]

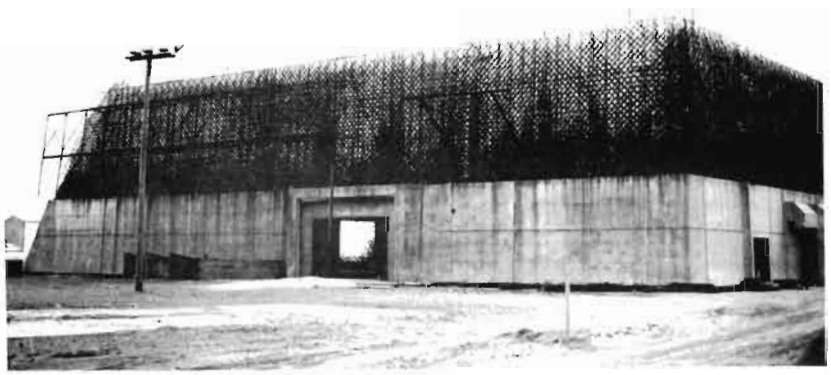
Every contract termination of this magnitude generates its own peculiar variety of wry feelings among the parties, and Malmstrom was no exception. For the contractors, subcontractors, and suppliers, compensation would eventually come in the form of Government payment for work done or materials supplied. For some Conrad-Shelby area citizens, the rather abrupt loss of anticipated free spending by construction workers and military personnel was balanced by the knowledge that the quiet life and stable environment of their locality would return and that federal funds would still be forthcoming to ease the adjustment period. But for Malmstrom area labor unions, the termination of construction activity was the last in a long line of bruises in the battle for higher wages and substantial benefits, and their reaction was correspondingly sour. On 2 June 1972, a week after the cessation of construction work, the North Central Montana Building and Construction Trades Council addressed a unanimous resolution to their Congressman, John Melcher, complaining that "it is now apparent that the manipulation of the 'on again - off again' status of the construction at Conrad, Montana, was nothing more than a card in an international poker game of strategic arms limits" and that "the long delay [of wage negotiations, 1970-71] was nothing more than a manipulated play in the game." The resolution further requested that "our elected representatives in the Congress of the United States take issue with the government contention that the high cost of labor was the reason for the long delay in staring the project."[9] Congressman Melcher's reaction to the resolution has not been recorded in Division files.

Final termination of the Malmstrom contracts and disposal of the sites could begin only after the final signatures were placed on the ABM Treaty on 1 October. On 2 October 1972 letters from the Department of Defense terminated all Malmstrom SAFEGUARD construction contracts as of 5 October. These contracts included DACA87-72-C-0019 with Peter Kiewit Sons' and Associates for the main buildings; DACA87-72-C-0060 and DACA87-72-C-0072 with Smith-Boeing for the four RLS's; and DACA87-72-C-0066 with Chris Berg for the Non-Technical Support Facilities. With the termination action, Huntsville Division instructed the contractors to remove forms, shoring, and equipment, but to continue operation of the Area Office waterline and to provide security for the sites pending disposition.[10] Area Engineer Col. L.B. Dezarn remained with a small staff to supervise custodial operations, and, ultimately, the close-out.

The final act in the unfortunate history of the Malmstrom ABM facilities came on 11 September 1973, when Huntsville Division awarded two contracts for cleanup and restoration of the sites to as near natural condition as practicable. Restoration work at the MSR site was to be conducted by William Clairmont, Inc., of Bismarck, North Dakota, for $364,000 and that at the PAR site and RLS 3 by PKS&A for $239,997.[11] Over the next six months these firms cut away protruding reinforcing steel, bundled it, and shipped it out for scrap salvage. The same treatment was given wiring, piping, fencing, light poles, and other salvageable fixtures. Roads, parking lots, curbs, gutters, trailer sites, the heat sink, waste water pond, and the SPARTAN and SPRINT holes were ripped up or filled in and landscaped. Various federal and

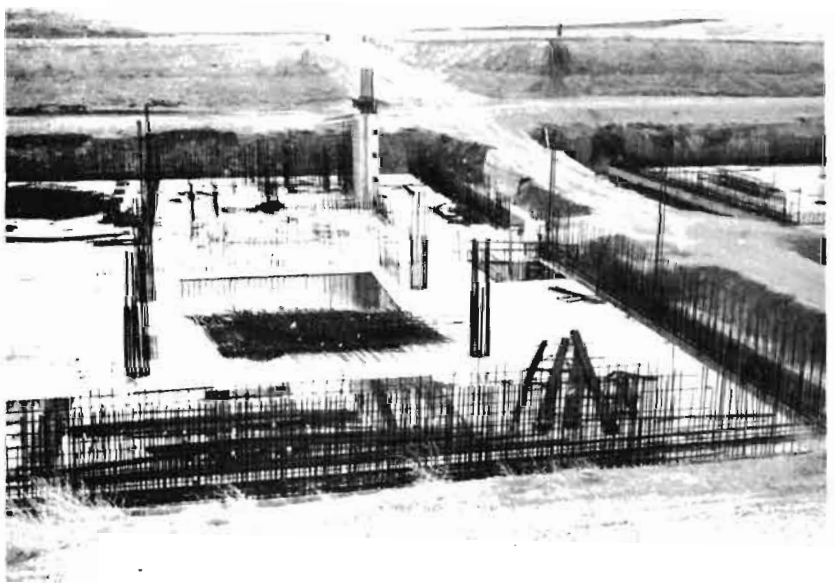


MALMSTROM PAR SITE prior to restoration and cleanup (September 1973). PARB in foreground facing the "A" wall, power plant in center, and heat sink in center left.

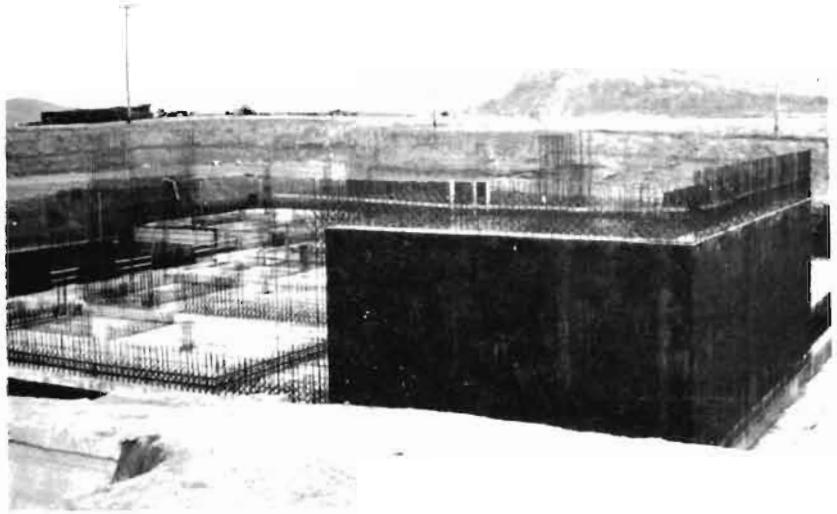


West Wall of Malmstrom PARB (September 73)

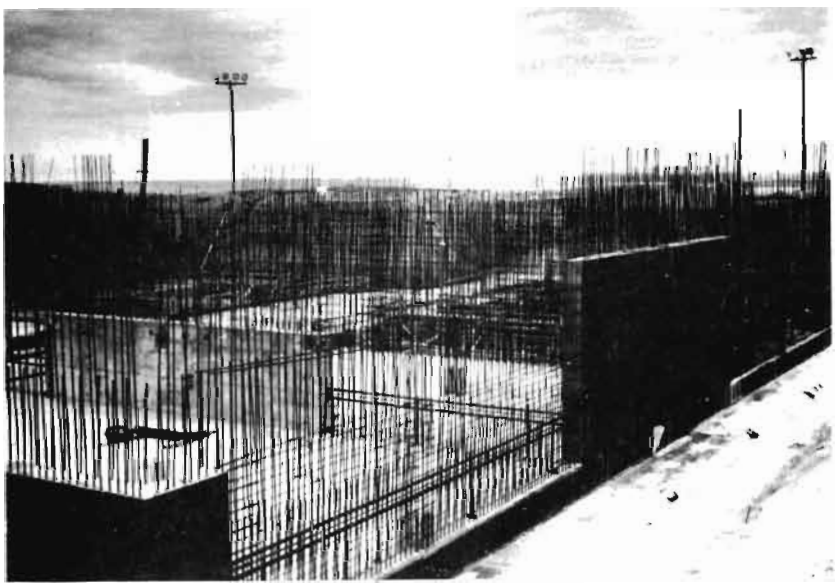
MALMSTROM PARB interior (September 73)



MONTANA MSCB with MSR Power Plant on right (September 73)



MSCB Montana September 73



MSCB Montana September 73

local agencies carried off most useful items--the excess office furniture and supplies, for example, were hauled to Malmstrom AFB Property Disposal. Most of the vast aggregate piles were tranferred to Pondera County, eventually to be spread over its roads; the Air Force claimed the PAR Resident Engineer's Office; and the complete PAR batch plant minus its 8,000 gallon buried water tank was requisitioned by the Bureau of Indian Affairs in Scottsdale, Arizona. As the final step, topsoil was bulldozed over the foundation ruins, graded, and seeded. By July 1974 most concrete remainders of the SAFEGUARD facilities at Conrad and Shelby had received a dignified burial beneath thousands of yards of earth and a waving cover of wind-blown grass. The unfinished first level of the PAR Building alone stood above ground as a mute monument to what might have been America's second ABM installation.[12]

MALMSTROM PAR SITE after restoration work. Buildings were donated to local government agencies. (May 1974)

MONTANA MSR SITE after restoration (May 1974) Building left were donated to local government agencies.

While the Malmstrom facilities were being buried under Montana earth, much of the rest of the SAFEGUARD program was being reduced or obliterated under piles of reorganization studies and disposal forms. Simultaneous with the termination of SAFEGUARD construction, the Defense Department also cancelled most of the $1.7 billion worth of weapons system production contracts outstanding with Western Electric Co., Raytheon Co., General Electric Co., McDonnell-Douglas Astronautics Co., and Martin-Marietta Corporation for radars and missiles since April 1968.[13] Out of these massive buys, only enough equipment and supplies for the Grand Forks and potential Washington, D.C..

sites were to be delivered, with a large part of the spares inventory for these being provided by items now on hand but surplus to the Malmstrom facilities. The Army decided for reasons of economy to provide remaining SAFEGUARD logistic support by contract rather than through Government agencies. In a major reorganization of the SAFEGUARD System, on 15 January 1973 the SAFEGUARD Logistics Command (SAFLOG) were merged with SAFSCOM to become the Logistics Management Directorate. The SAFEGUARD Army Depot at Glasgow, Montana, was converted into a Government-owned, contractor, operated facility, and the Central Training Facility at Fort Bliss, Texas, was dissolved. By the end of June 1973, personnel strength in support of the SAFEGUARD program had been reduced to about 58 percent of the manning level authorized prior to the signing of the ABM Treaty. The authorized civilian strength ceiling for the SAFSCOM infrastructure was trimmed to 1105 as of 30 June 1973.[14]

The implementation of the ABM Treaty and Congressional authorization of only one SAFEGUARD site posed several large questions for the Army regarding the long-range direction and organization that ballistic missile defense activities should take in the future. The ABM Treaty made another BMD deployment like SAFEGUARD problematical, but it set no bounds on BMD research and development. In the interests of national security, it was imperative to continue to explore the paths of advanced BMD technology, particularly the possibilities extended by the Site Defense program, should the Soviets abrogate the ABM Treaty. The Site Defense program involved a new generation of weapons systems and facilities intended from the beginning for defense of hardened ICBM sites.

In accordance with the dual needs of completing the Grand Forks SAFEGUARD site and continuing BMD research and development, the Secretary of the Army on 26 March 1974 announced plans to realign and consolidate BMD management under a single organization. This new direction was implemented on 20 May 1974 when the SAFEGUARD System was redesignated the Ballistic Missile Defense Organization (BMDO) and the SAFEGUARD System Command was renamed the Ballistic Missile Defense Systems Command (BMDSCOM). The assigned mission of the BMDO was to deploy and operate the SAFEGUARD System, execute the Site Defense program, to conduct research and development in advanced BMD technology, and manage the Kwajalein Missile Range. The Advanced Ballistic Missile Defense Agency (ABMDA) in Washington, D.C., and old and prestigious Government institution dated to the 1950's, was deactivated, and ABMDA Huntsville was redesignated the BMD Advanced Technology Center (BMDATC) under command of the BMD Program Manager.[15]

In the wake of reorganization and reorientation of SAFSCOM following the acceptance of the ABM Treaty, Huntsville Division's BMD mission remained very much as it had before the Treaty. Nor did the formation of the new hybird BMDSCOM in 1974 greatly affect the Division's client-patron relationship with the Army's ballistic missile defense command. When Huntsville Division was organized and mobilized in the fall of 1967, its mission had been defined as one of offering engineering and construction support for antiballistic missile deployment--in military language, the Division was a "BMD-dedicated organization." The promulgation of the ABM Treaty in October 1972 meant a drastic diminution in the active scope of the SAFEGUARD deployment, but it did not mean abolition, nor did it mean that there would not be other deployments of more advanced systems such as Site Defense in the future should the need arise. Potential future ABM deployments would require technical and non-technical facilities, just as SENTINEL and SAFEGUARD had, and logic dictated that Huntsville Division should execute the design and construction of these facilities. Hence, even though the ABM Treaty made the SAFEGUARD System a lame duck after 1972, a part of the Engineering Division staff continued to advance BMD concepts through the research and development of second and third generation facilities. At the same time, as the BMD mission shifted more and more to future possibilities rather than contemporary actualities, Huntsville's primary assignment remained the completion of the Grand Forks SAFEGUARD site and its guidance through checkout and acceptance by the Army Air Defense Command. The execution of this part of the Division's mission in North Dakota will be examined in more detail below.

While Huntsville Division's primary mission after the SALT I Treaty remained BMD facilities, the Division also began to broaden the scope of its activities through new mission assignments unrelated to BMD. One of the most outstanding requirements of the BMD program had been its massive GFP procurement. In the course of contracting for more than 1,600 line items of Tactical Support Equipment to be delivered to SAFEGUARD contractors,

Huntsville Division's Procurement and Supply personnel had acquired considerable expertise, experience, and reputation in the formulation of specifications and in the administration of large numbers of supply contracts for technical items. In November 1971 the newly reorganized United States Postal Service sought the managerial help of the Division in awarding and administering dozens of contracts for thousands of industrial mechanization items going into the Postal Service's new Bulk Mail Centers then being erected across the country.

The Postal Service mission became the first of a series of additional activities assumed by Huntsville Division during and after 1972. In May 1972, just as the ABM Treaty was concluded, Huntsville Division joined NASA in the Space Shuttle effort by providing design engineering and construction of those test facilities needed by Marshall Space Flight Center's portion of the Shuttle program. The Postal Service and NASA missions were later joined by others which, taken together, gradually changed the complexion of Huntsville Division from an institution solely serving the BMD community to one performing a variety of design engineering, construction, and procurement functions for a wide spectrum of Government agencies. Thus it can be fairly said that the phasing down of the SAFEGUARD program after the SALT I agreements of 1972 marked the beginning of a transition to a new era for Huntsville Division, an era in which the BMD mission was joined by a diversity of other types of technical challenges. This broadening and redirection of the Division's activities is further described beginning with Chapter V.

The transition to the post-ABM Treaty era was, of course, marked by manpower, personnel, and organizational adjustments within the Division. The limitations on SAFEGUARD imposed by the ABM Treaty and subsequent Congressional authorizations drastically reduced personnel requirements, and for a time during 1972 the prospects for the Division's future looked gloomy indeed. With the completion of SAFEGUARD, the Postal mission, and NASA tasks there could be little or no justification for maintaining Huntsville Division as a Corps field agency. During the course of 1972, however, the Department of the Army concluded that it would be prudent to maintain an engineering force-in-being as a contingency against future BMD facilities design and construction. By PBD 290 "SAFEGUARD" of 14 December 1972, the Division was authorized 240 civilian and ten military positions for BMD work; about sixty additional spaces were authorized for Postal and NASA missions. In FY 1975 further manpower studies provided 240 civilian spaces to be included in the Army's five-year defense program ending in FY 1981. These spaces preserved a Corps of Engineers presence in Huntsville with the primary mission of rapid deployment of additional BMD facilities should the provisions of the ABM Treaty be abrogated by the USSR. Under the terms of the Manpower Program, the Corps could utilize Huntsville Division in the performance of work of comparable sophistication as long as the ongoing BMD work retained top priority.[16]

Throughout FY 1972 the manpower level of the Division headquarters in Huntsville remained relatively stable, fluctuating between 425 on board on 30 September 1971 (430 authorized) to 418 on board on 30 June 1972 (437 authorized). Naturally, there was a good deal of growth in the field staff during this time because of the resumption of work at Malmstrom. Total Huntsville Division field personnel in the two SAFEGUARD area offices rose from 234 on 30 September 1971 to 299 on 30 June 1972. But after the signature of the ABM Treaty, a steady shrinkage in personnel manifested itself in keeping with smaller authorizations. One year and one month after the first signature of the Treaty, the actual military and civilian strength of the Huntsville office had fallen to 364 (373 authorized), with an additional 115 present in Grand Forks, ten at Malmstrom, and thirteen at the new Mississippi Test Facility Area Office opened for NASA work near Bay St. Louis, Mississippi. Two years after the Treaty, in June 1974, Division staff in Huntsville fell to 318 (292 authorized), with an additional sixty-four (thirty-eight authorized) in the field. By the end of FY 1975, the staff in Huntsville was reduced to 291 (310 authorized), with an additional thirteen (thirteen authorized) in field offices.[17]

In the era after SALT I, retirements and reassignments took the sting out of much of the reduction-in-force so that few "adverse actions" were required to keep the Division within operating authorizations. A scanning of the Division's "Historical Summaries" reveals that between 1970 and 1973 several original "plank owners" of 1967 retired or transferred away. Notables among them included Joe Harvey and John Coony in the Engineering Divisions; Margaret Jerge in the Personnel Office; William Campbell in the Office of the Comptroller; Ralph Loschialpo in the Personnel Office; and W.S. Worthington in the Safety Office. Quite probably the most notable changes of all occured in Divisional changes-of-command. On 13 April 1973 Col. Lochlin Caffey replaced Brig. Gen. Bates C. Burnell to become the Division's third Division Engineer. General Burnell was reassigned as commander of SAFSCOM,

COLONEL LOCHLIN W. CAFFEY
Huntsville Division Engineer
April 1973 - June 1975

COLONEL JOHN V. PARRISH, JR.
Huntsville Division Engineer
June 1975 - October 1977

physically a short move to new offices on the second floor of the same SAFEGUARD Building that housed Huntsville Division. Colonel Caffey led the Division until 30 June 1975, when he retired after thirty years of military service. His successor was Col. John V. Parish, Jr.

As noted above, Huntsville Division's primary reason for being after the ABM Treaty continued to be BMD facilities in general and SAFEGUARD construction in particular, with the new Postal Service and NASA support activities just getting underway. But the services of Government institutions really belong to the people, and public service has always come high on the list of Corps of Engineers' priorities, especially when its engineering talents are needed in an emergency situation. Through their involvement with water works and flood control, the Corps' geographic Divisions and Districts were no strangers to public emergencies, but Huntsville Division had no such familiarity since it had no civil works responsibilities. With the disaster created by Hurricane Agnes in June 1972, however, some fifty members[18] of Huntsville Division received an unscheduled initiation into the demands of flood relief.

Agnes, described by the National Hurrican Center as "the greatest rainstorm of all time," blew up the eastern seaboard states between 17 and 23 June with 110 mph winds, leaving behind a swatch of staggering destruction caused mostly by flooding. The storm's greatest impact was felt over the five state area of Pennsylvania, Virginia, West Virginia, Ohio and New York, where Agnes dumped an estimated 28 trillion, 100 billion gallons of water during her death agonies. The greatest amount of suffering was in Pennsylvania, where more than 70,000 homes were damaged or destroyed at a cost of more than $500 million. Damage surveys revealed 4,300 permanent residences destroyed, 31,400 with major damage, and 31,500 more with minor damage. An additional 1,300 mobile homes were destroyed and 1,900 damaged. It was by any measure a national catastrophe of the first magnitude.

The "Disaster Relief Act of 1970" (P.L. 91-606) provides for assistance to communities and individuals in recovering from damage caused by major disasters from natural causes. On 23 June 1972 the President declared certain areas in Pennsylvania, Maryland, Virginia, West Virginia, and New York as being subject to a major disaster classificiation because of Hurricane Agnes' flooding. The resources of

Corps of Engineers divisions and districts in the devastated region were overwhelmed, and on Saturday, 24 June, the Chief of Engineers reconnoitered the disaster area by air, determined that total Corps support would be required, and sent out radiotelephone messages directing a mobilization of all available individuals. By the next day, more than 100 personnel had assembled in Baltimore, and that figure grew to more than 400 over the next few days. Huntsville Division contributed more than fifty to this number, the members taking TDY and flying into the affected area for stays ranging up to several weeks. First priority was given to the restoration of human safety and public health, debris removal, and restoration of flood control structures. Much of this work was done by regular Army, National Guard, and reserve units, but as in other activities where the Government was a party, a great deal was done by contract with private individuals and firms. Contracting was a procedure in which Huntsville Division was expert, and Division personnel contributed heavily in this area. Frequently cleanup contracting was done on an ad hoc, on-the-spot fashion that slashed through red tape. As the Division's "Information Bulletin" put it,

> the first contracts in many cases consisted of a contractor informing the Area Engineer of his equipment and capability; the Area Engineer nodding; making a note of the facts; defining an area to work; and the man and crew going to work. The paper work was handled later.[19]

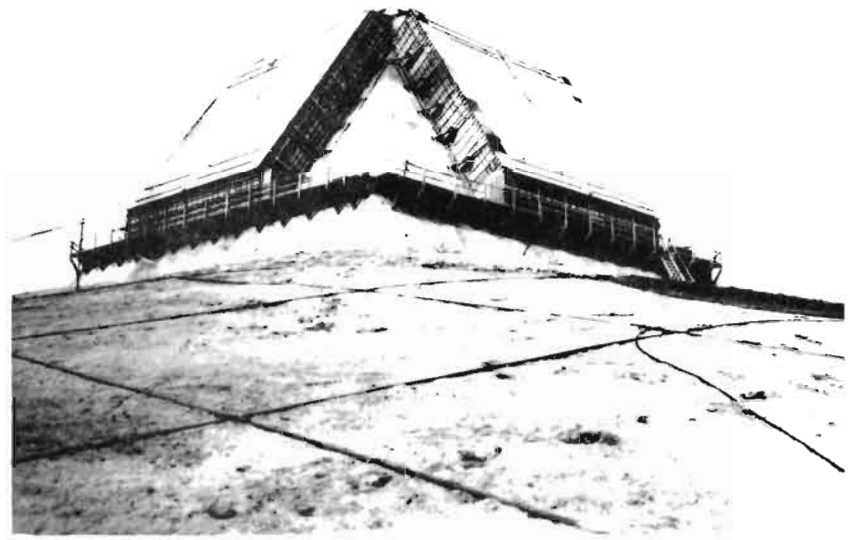
By 23 July, almost 1,900 contracts had been awarded at a value of over $34 million with work continuing. The final phase of the cleanup operation was conducted after 17 July by the Susquehanna District, a temporary district assembled specifically for the job. This office officially closed on 30 November 1972. By this time, however, most Huntsville Division employees had returned to the home office.

When the ABM Treaty was first promulgated in May 1972 the construction of the Grand Forks facilities was about 85 percent complete, and the work was roughly on schedule. BOD for the PAR Building had been established as 21 August 1972 and as 1 January 1973 for the MSR, and although the signing of the ABM Treaty lifted much of the pressure from schedules, the timely fulfillment of schedule commitments for Grand Forks represented one of the major objectives of Huntsville Division during the period of transition that followed the Treaty. Preparation for the turn-over of the sites to ARADCOM, the using command, had already gotten underway in September 1971 when the Army Air Defense Command announced creation of the first two units to man SAFEGUARD installations. The units formed as of 1 September 1971 were the Army SAFEGUARD Command, Grand Forks, with an authorized strength of 784, comprised of 62 officers, 22 warrant officers, 432 enlisted men, and 168 civilians. Their mission was to "defend the Continental United States from a ballistic missile attack; specifically, to establish an area defense for existing retaliatory missile sites." This unit would man the MSR and be the command element for the Grand Forks SAFEGUARD detachment. The second unit, the Army Surveillance Battalion, Grand Forks, was assigned to the PAR with the mission of providing long-range surveillance and early warning of a ballistic missile attack against the Continental United States. The Battalion's authorized strength of 401 called for 41 officers, 14 warrant officers, 209 enlisted men, and 136 civilians. Contemporary 1971 plans called for a similar unit at Malmstrom; these plans were scrapped along with the Malmstrom site after October 1972.[20]

Construction at both the PAR and MSR had continued throughout the winter of 1971-1972 without unusual problems because the buildings were fully closed in and on extensive winterization provisions were required. By this time all major structural concrete pourings were complete except for minor "fill-in" around the tardy MSR antenna rings, hence the bulk of activity at both the PAR and MSR centered about the myriad of detail work necessary to finish up the interior of the buildings and install mechanical and electrical systems. At the close of the 1971 construction year on 31 December, 53 percent of the mechanical and 42 percent of the electrical work was finished in the MSR Building; corresponding figures are lacking for the PAR but were doubtless much higher than this.[21] By the end of the year the MSR SPRINT field was virtually complete with all sixteen missile cells set and backfilled; in the SPARTAN field, all concrete and backfilling had been completed and the contractor had begun to install liner plate for RFI/NEMP shielding. At this time the Universal Missile Building was about 86 percent complete; the Warhead Handling Building was structurally complete and about 50 to 60 percent fitted with mechanical and electrical components. At the PAR, most of the late 1971 construction season was spent setting and welding liner plate, installing phase shifter platforms, erecting metal partitions, installing blast doors, and assembling the shock isolation platforms.[22]

For the most part, M-KA was able to make steady and rather uneventful progress through the detail

work of the winter season. Perhaps the most spectacular, if not the most damaging, setback came on 20 January 1972, when an early-morning fire gutted the forty-three trailer M-KA office trailer complex. The blaze destroyed many records and caused $2 million in damages, but there were no injuries and full operations were resumed in about a week. [23] When the winter snows of 1971-1972 were shaken off and work commenced in the 1972 season, weapon system



MSCB Turret (April 1972)

contractor personnel were already appearing in some numbers in preparation for installation of the radar equipment. This part of the construction was not properly part of the Corps of Engineers' responsibility, but it often involved a close mesh with the Corps' contractor, M-KA. This was particularly true in the installation of the MSR turret rings which had to be assembled and aligned with test jigs, then permanently set in concrete. The first of the rings began to be assembled in April; the installation and test alignment of all thirty-six segments had to be completed on one face before the adjoining wall surfaces could be filled in with concrete. The fourth and final ring was assembled, aligned, and set by the middle of July. With the setting of the antenna rings and the removal of construction scaffolding, the truncated pyramid shape of the MSR was clearly revealed for the first time.

The installation of thousands of external radar elements on the face of the "A" wall of the PAR Building represented a different and far more spectacular scene as the building neared acceptance during the spring and summer. Clinging like flies on the nearly vertical face of the 120-foot wall, dozens of WECo technicians brought up thousands of small machined bits and pieces and painstakingly assembled them over the 6,500 four-inch perforations through the "A" wall face leading to the phase shifter equipment inside. Writing in the Division's "Information Bulletin," the Historian likened the curious process to some kind of fantastic Christmas Eve played out on a grand scale:

> What parent hasn't been frustrated on Christmas Eve --after the kiddies are in bed -- trying frantically to assemble all the loose nuts, bolts, washers, and panels of a doll house, tricycle, or swing set? The "easy-to-follow" instructions never seem to quite match all the loose parts strewn over the living room floor. The problem at the Grand Forks Safeguard complex could be somewhat the same. . .when the contractor begins erecting the front face ground plane and edge seal forming the 120-foot diameter radar "eye" on the PARB.

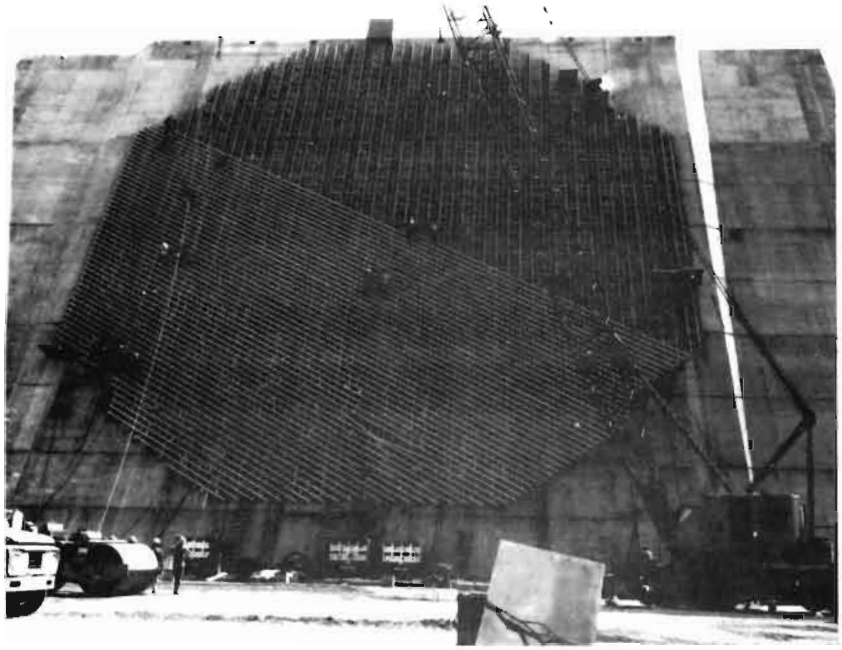
Then the writer went on to underline the complexity and precision involved in WECo's Christmas Eve parent role:

> The total hardware for the working "eye" consists of 245,828 individual pieces -- bolts, screws, washers, gaskets, seals, frames, plates, and channels. It could be called the world's largest erector set. The component parts will be fabricated to precise dimensions by at least

three different manufacturers and about 10 suppliers, piece-marked and shipped to the job site. Because of the magnitude of the structure, preassembly before erection is unfeasible. Under the Area Engineer's supervision, the contractor must erect over 175,000 of these pieces and end up with a plane surface about 120 feet in diameter, flat from edge to edge within 1/4-inch tolerance, and with its 6-thousand plus holes all within 1 inch of true position. This involves properly matching and aligning over 40,000 bolted connections, each torqued to predetermined requirements. After the construction contractor's erection is completed, the Weapon System Contractor (WSC) will install and cable-up the remaining 70,000 individual pieces that make up the 6-thousand plus radar elements.[24]

The installation of the antenna ground plane on the PAR Building face was the last major step to be taken before the building could be turned over to the site activation team from SAFSCOM. As the antenna installation drew to a close in June 1972, prefinal inspections were going on throughout the PAR Building with painters, electricians, and plasterers performing the final stages of finishing work. Last minute cleanup and housekeeping were accompained by a flurry of activity, but the contractor was ready when the long awaited BOD arrived on 21 August 1972. The event was one of the most significant milestones in the history of Huntsville Division, and it was duly noted with a small "turn-over" ceremony at the PAR. Division Engineer General Burnell made some brief remarks and passed control of the PAR from the Corps of Engineers to Brig. Gen. John E. Sterling, Director of Site Activation for SAFSCOM. With the transfer of the PAR Building, representatives

PAR FACILITIES of the SAFEGUARD Ballistic Missile Defense near Grand Forks, North Dakota, as they appeared on April 19, 1972. At the upper left is the PAR control building with its associated power plant to the right. In the background are some of the support facilities of the installation. In the center and on the right are temporary contractor buildings and workers' automobiles.



THE FACE PLAIN of the Perimeter Acquistion Radar Building (PARB) as it appeared in later June 1972.

of Western Electric Co., the weapons system contractor moved into the building and began installation and testing of tactical equipment for the building.[25] M-KA met with even more success in completing the adjoining PAR Power Plant, BOD for which was reached on 18 November 1972, twelve days ahead of schedule.

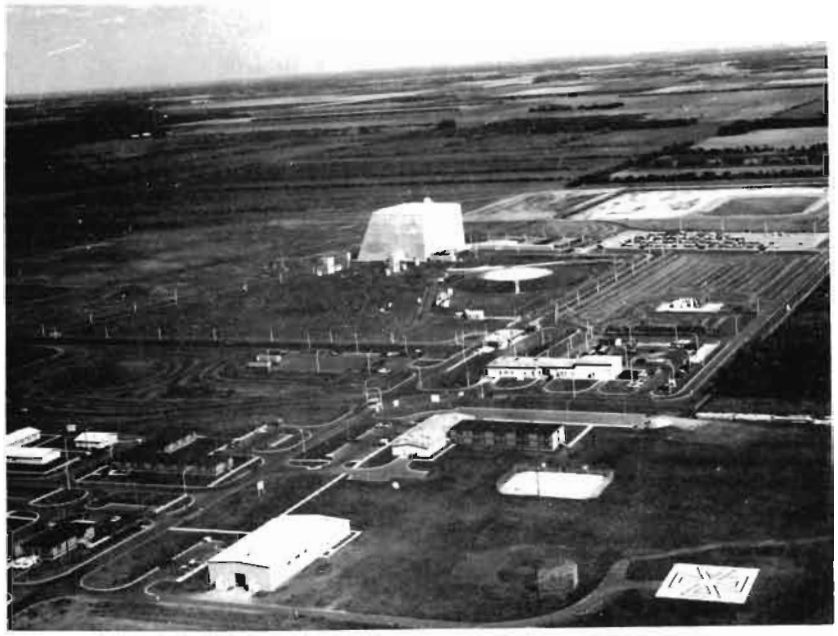
TRANSFER OF THE FIRST OF THE MAJOR TACTICAL BUILDINGS OF THE NORTH DAKOTA SAFEGUARD BALLISTIC MISSILE DEFENSE SYSTEM, the Perimeter Acquistion Radar Building, from control of the Huntsville Division to the Safeguard System Command on August 21, 1972. From left to right: S.N. Purinton, PAR Project Manager, M-KA; G.W. Gilfillan, Division Manager, Missile and Space Division, M-K; A.D. (Doc) Poteat, Resident Manager, M-KA; Paul C. Steidl, PAR Resident Manager; Colonel Lochlin W. Caffey, Contracting Officer and Deputy Division Engineer, Huntsville; Brigadier General Bates C. Burnell, Huntsville Division Engineer; Barney L. Trawicky, Chief, Construction Division, Huntsville; and Colonel John L. Lillibridge, Grand Forks Area Engineer.

The second major portion of Grand Forks facilities was released for occupancy on schedule on 3 January 1973, when the Corps of Engineers transferred the MSR Building to the SAFSCOM Site Activation Team. As with the PAR, a brief ceremony conducted by General Burnell marked the occasion. Other participants included representatives of the Area Office, SAFSCOM, M-KA, and WECo. With the transfer to SAFSCOM, WECo employees moved in to initiate the installation and testing of the tactical equipment, completion of which operation was scheduled for 1974. BOD for the MSR Power Plant was 4 March 1973, twenty-six days in advance of the construction schedule date of 1 April 1973.[26]

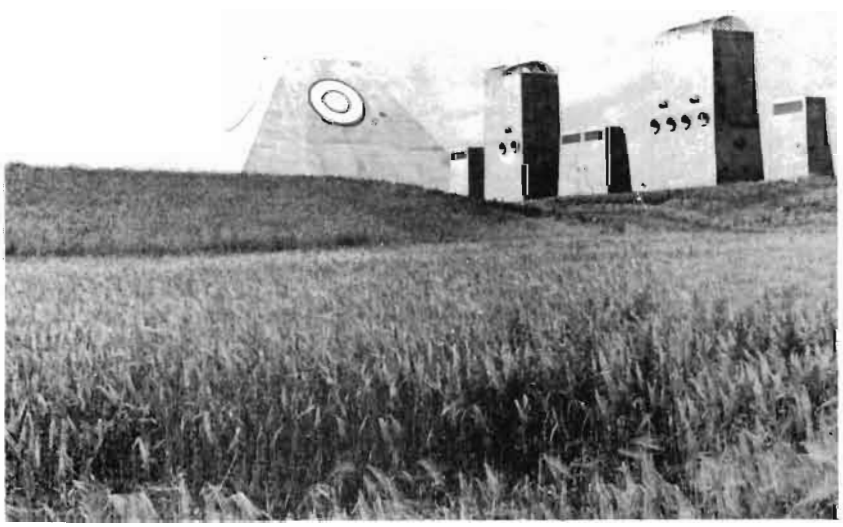
An evaluation of Grand Forks SAFEGUARD contractor performance is a difficult matter. All contractors were under firm pressure from the Defense Department's deployment schedule to meet all deadlines in the interest of national security. Additionally, all contractors on technical facilities faced novel techniques, technical sophistication, massive numbers of changes, high quality demands, and natural geographic and demographic obstacles to their jobs. Officially, the Corps' Form 1596 "Construction Contractor Evaluation Report" completed at the termination of proceedings gave all three major Grand Forks contractors a "satisfactory" rating on all five evaluation criteria and an overall "satisfactory" rating.[27]

In meeting or exceeding the expected BOD dates, M-KA had generally turned in a more than satisfactory performance on the Grand Forks sites. It should be remembered, however, that the talent and resources available to this construction giant were immense. As shown by the last edition of the Ballistic Missile Defense Systems Command Site Activation Program Status Report (SSCS-127), 31 October 1974, the other contractors were delayed somewhat more by changes in achieving their schedule objectives. Chris Berg, contractor for the Non-Technical Support Facilities, turned over the MSR Community Center on 5 December 1972, four months after the anticipated BOD; the MSR Chapel, received on 6 October 1972, was two months beyond the schedule date; the Industrial Building was two and three-quarters months later than scheduled; and the MSR Gymnasium, completed on 7 February 1973, was more than two months behind schedule. At the PAR site, the PAR Gymnasium was completed on 9 February 1973, more than two months after its scheduled BOD of 15 November 1972; most other Non-Technical Support Facilities at the PAR had averaged about a month's overrun.[28]

TACTICAL FACILITIES OF THE SAFEGUARD BALLISTIC MISSILE DEFENSE SYSTEMS' MISSILE SITE RADAR site constructed near Grand Forks, North Dakota. Right foreground is the Helipad; right is the circular underground heat sink; to its left the intake and exhaust stacks of the underground power plant; the turret of the partially buried Missile Site Control Building; to the left the Spartan and Sprint Missile Fields; and the mounded earth covered Missile Assembly Building.



THE PERIMETER ACQUISTION RADAR SITE BEING CONSTRUCTED NEAR GRAND FORKS, NORTH DAKOTA. In the foreground are the nontactical and support facilities, in the center the Perimeter Acquisition Radar Building, the intake and exhaust stacks of the Power Plant, the circular buried Heat Sink and in the background the waste disposal systems.



THE TURRENT OF THE MSCB and the intake and exhaust stacks of the underground power plant.

THE NORTH SIDE or face of the PARB with the intake and exhaust stacks of its underground power plant on the right.

A large number of engineering changes caused Woerfel Corporation & Towne Realty, Inc., the most difficulty in meeting schedule dates. The venture's prior experience had been mostly in the field of real estate and residential construction, where it was well qualified, but in taking on the four RLS contracts it had, as the expression goes, "bitten off all it could chew." The "History of the Grand Forks Area Office" bears testimony to Woerfel & Towne's performance problems on the highly sophisticated technical work, encumbered as it was by the significant design changes. A typical entry from the "Area Office History" dated 20 November 1972 is indicative of these difficulties:

> **20 Nov 72:** The plethora of clarifications and "how to" do the work continues to flow to this Contractor. . . .At one point Woerfel said he was astonished by the magnitude of the work involved in this contract.[29]

Under these circumstances, it is hardly surprising that a considerable slippage was generated in completion of the RLS facilities. RLS 1 was slipped from 11 July 1973 until 20 November 1973; RLS 2 from 15 June to 26 September 1973; RLS 3 from 5 July to 26 September 1973; and RLS 4 slipped from 15 August until 5 November 1973.[30]

The passage of BOD dates for Grand Forks marked completion of the bulk of the Corps of Engineers' responsibility for construction of these facilities. Corps work at the site continued, however, in maintenance, supervisory, and testing roles for sometime. Several lesser contracts were awarded during this phase-down period for miscellaneous services. A large part of maintenance and operations services were done under a $1.1 million contract with the Federal Electric Corporation (FEC) on 4 August 1972. FEC was to operate and maintain the tactical support equipment from 1 September 1972 until 30 June 1973, with options to carry through to 30 September 1974. FEC's responsibilities included the power generators, heating, air conditioning, electrical distribution, monitoring and control, plant mechanical, environmental, fire detection, fire alarm, and fire suppression systems and related apparatus. Under this contract FEC was also to conduct a formal training program at Grand Forks, preparing Army personnel to replace the FEC technical team when the contract expired.[31]

While the duties and staff of the Corps' Area Office dwindled during 1973 and 1974, the testing, verification, and acceptance of the SAFEGUARD weapons system proceeded under SAFSCOM direction. Operation of the PAR radar, the first full scale model in existence, began in June 1973 as part of the installation and testing program, and tests showed that the PAR could track from its minimum to its maximum range using the entire visibility angle for which it was designed. By early October the PAR was tested at full power and successfully tracked earth-orbiting satellites ranging in size from a basketball to

the largest objects then in space. On 3 September 1974 the U.S. Army SAFEGUARD Command (SAFCMD), Nekoma, North Dakota, and the Ballistic Missile Defense Operations Activity (BMDOA), Colorado Springs, Colorado, were established as the operational elements for the SAFEGUARD System. On the same date, the SAFSCOM Site Activation Commands at the two locations were relieved. Ceremonies held at Nekoma, North Dakota, and Colorado Springs, Colorado, on 27 September 1974 marked Government acceptance of the SAFEGUARD System at Grand Forks. Four days later, on 1 October 1974, the SAFEGUARD System met its Equipment Readiness Date and SAFCMD assumed responsibility for operation and maintenance. A memorialization ceremony held on this date officially named the North Dakota site the "Stanley R. Mickelson Complex." Following the Equipment Readiness Date, five contractor demonstration tests were run at the Mickelson Complex against various BMD scenarios. These tests led to initial operational capability of the System. Between 8 February and 6 June 1975 the Mickelson Complex received its complement of nuclear SPARTAN and SPRINT missiles under Operation "Green Mittens," and on 1 April 1975 the Complex was declared operational with twenty-eight SPRINT and eight SPARTAN missiles in inventory.[32]

As it happened, the operational career of the Mickelson SAFEGUARD Complex proved to be less than a year. The signature of a Protocol to the ABM Treaty on 3 July 1974 limited American and Soviet ABM deployment to one site, and Congress subsequently acted to eliminate operation of the one facility allowed. In February 1976 the only SAFEGUARD facilities to reach operational status were "abandoned in place" and put on a caretaker status. As of the present, there seems to be no interest in reviving their use for BMD or other purpose.[33]

The formal termination of Corps of Engineers presence at Grand Forks came on 27 June 1975 when the doors of the Grand Forks Area Office were locked for the last time. By this time, construction of the facilities was rapidly becoming a matter of record with the conclusion of negotiations for final contract settlements. The most significant of these settlements came on 4 April 1974, when a formal Memorandum of Understanding was reached between Huntsville Division and M-KA. Under the terms of the Understanding, all change orders and claims against the Government under construction contract DACA87-70-C-0013 were settled for $61,200,000. This was in addition to the basic contract price of $137,731,439.00, bringing the total price paid to M-KA for the main Grand Forks facilities to a total sum of $198,931,439.00.[34] The final figure represented an escalation of 44 percent over the original contract price, but several considerations must be borne in the mind when evaluating this increase. During the four years of construction, the rate of inflation in the nation's economy had run about 6 to 8 percent per year, and although M-KA's contract was fixed-price, inevitably some inflation adjustment crept in on all changed work items. Additionally, and most importantly, it must be remembered that the Grand Forks facilities were the first SAFEGUARD facilities completed, and thus they bore the brunt of thousands of modifications and change orders resulting from subsequent implementation of engineering designs produced in great haste during 1968 and 1969. Undoubtedly later facilities, had they materialized, would have benefited substantially from the pioneering forged with Grand Forks. Finally, what price can be put on the technical, contractual, and constructional expertise gained, or the worth of this demonstration of American technological competence and determination to defend herself while SALT talks were being conducted? These contributions were perhaps best recognized by Assistant Secretary of the Army, Norman R. Augustine, in August 1974 ceremonies marking acceptance of the SAFEGUARD System from its prime contractor, Western Electric Company. On this occasion, he said that the SAFEGUARD System "represents in terms of enormity and difficulty of technical challenge one of the three or four most demanding undertakings in history." He also spoke of SAFEGUARD's influence in attaining the ABM Treaty and the Interim Offensive Weapons Agreement with Russia: "The benefits in terms of peace for peoples throughout the world are the real payoff." No higher compliment could be paid to the SAFEGAURD System and to the Corps of Engineers which had contructed it.

CHAPTER IV FOOTNOTES

[1]The text of the ABM Treaty is in U.S. Department of State, **United States Treaties and Other International Agreements,** Vol. XXIII, Pt. 4. "Limitation of Anti-Ballistic Missile Systems," TIAS No. 7503, May 26, 1972, pp. 3437-3447.

[2]USAEDH-PAO, "Historical Summary FY 1972," II, Documents, pp. 29-31.

[3]**New York Times,** 3 October 1972, p. 1.

[4]USAEDH-PAO, "Historical Summary FY 1972," I, Narrative, pp. 135-137.

[5]Ibid., 195-199.

[6]Memo to the author from James W. Reynolds, Contract Specialist, Procurement and Supply Division, 20 June 1978. Each GFP contract included a clause entitled "Delay of Work." This clause provided for an adjustment in the contract price if the Government or contracting officer took an action or failed to take an action which caused a delay in the contractor's performance of the contract. None of the contracts included a "Suspension of Work" or "Stop Work" clause which would have allowed the Government to stop or suspend temporarily the contractor's performance. These clauses were not required to be included in fixed-price supply contracts. A notice to terminate the contracts for the convenience of the Government could not be issued because the full impact of the treaty ratification was not immediately known. On the other hand, the contractors could not be allowed to continue performance on the contracts for the future requirements of the ABM system. In the absence of any more appropriate alternative, the decision was made to issue a notice to the contractors involved directing a delay of work pursuant to the "Delay of Work" clause although the clause does not specifically permit such direction.

[7]Memo to the author from Thor S. Anderson, Chief, Procurement and Supply Division, 16 June 1978.

[8]USAEDH-OC, "History of the Office of Counsel," Supp. 5 (Oct. 1971 - Oct. 1972), p. 15.

[9]USAEDH-OC, "History of the Office of Counsel," Ex. 297, letter of North Central Montana Building and Construction Trades Council to Congressman John Melcher, 2 June 1972.

[10]USAEDH-PAO, "Historical Summary FY 1973," I, Narrative, pp. 57-58.

[11]USAEDH-PAO, "Historical Summary FY 1974," II, Documents, pp. 115-116.

[12]For disposition activities at Malmstrom between September 1973 and July 1974 see the Weekly Area Reports in USAEDH Office of Counsel file 401-07, SAFEGUARD Status Reports Malmstorm 1973 and 1974.

[13]BMDSCOM, "Summary of the SAFEGUARD Program, FY 73," p. 7; **Huntsville Times,** 5 October 1972.

[14]BMDSCOM, "Summary of the SAFEGUARD Program, FY 73," pp. 1-2.

[15]BMDSCOM, "Ballistic Missile Defense Program Summary, FY 74," pp. x-xi.

[16]USAEDH-PAO, "Historical Summary FY 1975," I, Narrative, pp. 1-2; personal interview with Dewey Rhodes, Manpower Management Officer, 3 August 1978.

[17]USAEDH-PAO, "Historical Summary FY 1972," I, Narrative, p. 1; USAEDH-PAO, "Historical Summary FY 1973," I, Narrative, p. 1; USAEDH-PAO, "Historical Summary FY 1974," I, Narrative, p. 2.

[18]The figure of eighty individuals from Huntsville Division is given in USAEDH-OC, "History of the Office of Counsel," Supp. 5 (Oct. 1971 - Oct. 1972), pp. 6-7.

[19]USAEDH-PAO, "Information Bulletin," V, No. 7 (9Aug. 1972), pp. 1-4.

[20]USAEDH-PAO, "Information Bulletin," V, No. 1 (14 Jan. 1972), pp. 1-2.

[21]USAEDH-GF, "History of the Grand Forks Office," Pt. I, FY 1972, pp. 84-87.

[22]Ibid.

[23]Ibid., pp. 91-92.

[24]USAEDH-PAO, "Information Bulletin," IV, No. 18 (19 Nov. 1971), pp. 1-2.

[25]USAEDH-PAO, "Information Bulletin," V, No. 8 (25 Aug. 1972), pp. 1-2.

[26]USAEDH-PAO, "Information Bulletin," VI, No. 1 (24 Jan. 1973), p. 1.

[27]Government Form 1596 "Construction Contractor Evaluation Report" offers only two choices in evaluating contractors' performance, "satisfactory" and "unsatisfactory." According to Edwin Kircher, Trial Attorney (Contract), Office of Counsel, it is unusual for a contractor's performance to be classified as "unsatisfactory."

[28]BMDSCOM, Site Activation Program Status Report (SSCS-127): Grand Forks, 31 Oct. 1974, pp. 2-23, 4-17.

[29]USAEDH-GF, "History of the Grand Forks Office," Pt. III, DACA87-71-C-0055, FY 1973, p. 55.

[30]BMDSCOM, Site Activation Program Status Report (SSCS-127): Grand Forks, 31 Oct. 1974, pp. 6-4, 6-8, 6-12, 6-16.

[31]USAEDH-PAO, "Information Bulletin," V, No. 8 (25 Aug. 1972), p. 2; USAEDH-PAO, "Historical Summary FY 1972," II, Documents, p. 62.

[32]BMDSCOM, "Ballistic Missile Defense Program Summary, FY 74," pp. xi-xiv; BMDSCOM, "(U) Summary of BMDSCOM Activities, FY 75," pp. xiii-xvii; BMDSCOM, "Summary of BMDSCOM Activities, FY 76/7T (sic)," pp. xii-xviii.

[33]BMDSCOM, "Summary of BMDSCOM Activities, FY 76/7T **(sic)," pp. xv-xviii.**

[34]Memorandum of Understanding with M-KA, 4 April 1974, USAEDH-OC file Morrison-Knudsen Co. & Associates Correspondence 1974, Contract DACA87-70-C-0013.

CHAPTER V

A NEW ERA FOR HUNTSVILLE DIVISION

The history of Huntsville Division in the period 1972 through 1976 represents a sharp contrast with the first five years of it existence. Organized in 1967 with an exclusive dedication to BMD facilities design and construction, the Division then had a mission with high national security implications, large funding, great technical sophistication, and close interaction with the social, political, and economic environment of the times. Thus, the BMD mission remained the Division's single focus for the next five years. After 1971, however, the single orientation of the Division began to give way to a broad variety of new missions as BMD settled back into the research and development status it had enjoyed before the deployment decision of 1967. With the assumption of new and various tasks for a diversity of military and civilian customers, the second era in the history of Huntsville Division began.

In November 1971, even before the impact of a SALT treaty was felt, the Division had been handed a large-scale procurement mission for the newly created United States Postal Service; in 1972 the Postal Service was joined by another civilian customer when the Division was asked to design and construct several test facilities needed for NASA's Space Shuttle program. In late 1973 a third customer, the U.S. Army Material Command (AMC), was added to a growing list of patrons when the Division assumed responsibility for facility design and construction of the Army's massive nationwide Munitions Production Base Support Construction Program (MPBSCP). Finally, in 1975 and 1976, Huntsville Division became involved in the Energy Research and Development Agency (ERDA) coal conversion program, with planning for a Jordanian Armor Rebuild and Conversion Facility, and with procurement for the Corps of Engineers construction activities in the Kingdom of Saudi Arabia. By the end of 1976, Huntsville Division had been, or then was, engaged in a multiplicity of tasks, none of which resembled the Division's original BMD birthright.

The many-sided face of the Division's new era, however, was somewhat deceiving, because in each of the new missions assumed, one or more of three factors common to the Division's BMD heritage could be identified. Several of the new assignments--the Postal mission, the MPBSCP, and the Saudi Arabian mission, for example--revolved around the need to bring a degree of central coordination and management to a national (or even international) program that was quite suited to the capabilities of the Huntsville Division. Second, many of the Division's new tasks were concerned with large-scale and long-range procurement of technical, mechanical, or industrial items similar to the procurement carried out under SAFEGUARD's GFP program. Third, a need for the development and application of highly sophisticated engineering criteria in technical, mechanical, or industrial construction could be especially identified in the ERDA and MPBSCP missions and to a lesser degree in the NASA Space Shuttle and Jordanian Armor Rebuild Facility missions. Taken separately or in combination, exceptional proficiency in these unusual requirements mandated that the responsibilities of the Huntsville Division remained, as in its first five years, unique within the Corps of Engineers.

The phasing in, execution, and phasing out of several complicated programs over several years makes a purely chronological account of them more confusing than clarifying. It should be noted, too, that the Division's internal organization was often reshaped along functional lines in correspondence with the new missions. Certain divisions, branches, or sections sometimes bore primary responsibility for one or two missions only. The Postal mission, for example, was largely, though not exclusively, the work of specialized postal branches within the Procurement and Supply Division, with the Division having no engineering design responsbility. Similarly, other specialized offices for NASA engineering and construction and for Saudi Arabian support appeared on Divisional organizational charts as the need arose. For reasons of clarity, therefore, a topical and functional rather than a year-by-year treatment of Division activities after 1971 has been followed. This Chapter describes the Postal and NASA missions; the MPBSCP, ERDA, Jordanian, and Saudi Arabian missions are considered in subsequent chapters.

The Bulk Mail Centers Procurement for the U.S. Postal Service

The origins of Huntsville Division's bulk mail center procurement for the U.S. Postal Service can be found in the formation of the USPS as a semi-autonomous agency and a concomitant effort to modernize and mechanize its mail handling functions. By the later 1960's, the facilities and operations of the United States Post Office Department were generally

recognized as outdated and inefficient. In an age of automation, computers, and assembly line mechanization, the Post Office Department continued to do business much as it had twenty-five or even fifty years before. Most of the nation's mail, whether letter or package, was still hand sorted and hand delivered. Moreover, most of the Department's operations were notably unspecialized, all kinds of mail handling being carried on in multi-task facilities located in downtown urban areas. These congested conditions made access for trailer truck mail carriers difficult, while the buildings themselves were of monumental "Federal Style" architecture, expensive to build and almost equally costly to convert or maintain.

By the end of the 1960's, the deficiencies inherent in the Post Office Department's operations were being exposed and aggravated by a rapidly increasing volume of mail passing through the system each year. A thorough reform of the Department seemed in order, and the impetus towards that reform was provided in 1969 when newly-elected President Richard M. Nixon appointed Winton M. Blount as Postmaster General. Blount's reform ideas were inspired by his background as a successful businessman in private life; as Postmaster General he attempted to apply the principles and methods that had been successful in American industry to the modernization of the Post Office Department's infrastructure. Soon after becoming Postmaster General, Blount inaugurated a far-reaching plan to remove the Department from the arena of national politics by having it reorganized as a public corporation called the United States Postal Service (USPS). Thus rendered semiautonomous, the Service would be able to carry out sweeping reforms and modernization and perhaps even be able to free its budget from annual Congressional subsidies.

One of the linchpins of Blount's reforms was subdivision of the USPS into fifteen Postal Regions with regional headquarters in major cities. Another was a virtual revolution in the handling and sorting of mail based on the differentiation of mail types and a high degree of mechanized processing. Beginning about 1970, mail flow in the United States would take two broad channels according to priority and weight. First class letters and other high-priority articles termed "preferential mail" would be routed through automated machinery in Preferential Mail Centers (PMC's) and local post offices. According to the Blount plan, several hundred PMC's and smaller postal facilities would be newly built, renovated, or expanded to accommodate machine handling of preferential mail.

Paralleling the preferential mail system and integrated with it at Post Office inlets and outlets was a Bulk Mail System which would comprise a national network of twenty-one physical plants--the Bulk Mail Centers, or BMC's--located on the periphery of urban areas and near modern transport facilities, interstate highways, and airports. The completed system would include two large BMC's outside New York and Chicago; five medium BMC's near Los Angeles, California; Pittsburgh, Pennsylvania; Philadephia, Pennsylvania; Springfield, Massachusetts; and Dallas, Texas; and fourteen other Small BMC's. Designed along functional lines without the requirements to act as public post offices, the Centers were essentially light industrial-type utility buildings sheltering computerized mechanisms and other high speed mail handling equipment to sort packages, parcels, and other bulk items. The multistory facilities ranged in size from seven to twenty-five acres under roof. The total cost for the Bulk Mail System program was at the time projected at more than $950 million with an estimated annual cost savings of approximately $300 million, or over $800,000 per day (1971 dollars). The System was to be operational by FY 1975 in order to maximize the economies anticipated from its implementation.[1]

The construction envisioned for the Preferential and Bulk Mail Systems was an ambitious undertaking, and in carrying it out the Postal Service had several options. The Service itself should have carried out the construction, even though it lacked the capacity and would have had to resort to a rapid, massive, and rather wasteful buildup of specialized managerial and engineering talent that would be rendered superfluous after the program was finished. Other Governmental agencies such as the G.S.A. likewise seemed to lack the capability, personnel, or expertise to tackle a construction task of this magnitude.[2] By comparison with other options, utilization of the U.S. Army Corps of Engineers offered several advantages. The Corps of Engineers was a substantial force-in-being with an enormous repository of experience with complex, special purpose construction projects. Since the Corps was already a well-established, functioning organization, it could immediately assume responsibility without a large-scale recruitment and mobilization campaign. Its decentralized regional network of divisions and districts enabled the Corps to easily adapt to the extensive work required. Finally, the additional burden of the Postal Service support mission could be assumed efficiently, without

exaggerated increases in personnel or adverse impact on its other activites.[3] A legal authorization for such military assistance to a civilian agency was specifically asserted in Public Law 89-298, Section 219 (79 Stat 1089, Title II, "Flood Control Act of 1965"), which states:

> The Chief of Engineers, under the supervision of the Secretary of the Army, is authorized to accept orders from other Federal departments and agencies for work or services and to perform all or any part of such work or services by contract.[4]

The Post Office Department extended initial overtures for postal construction to the Chief of Engineers in March 1969, only a few months after Postmaster General Blount took his seat in the Nixon cabinet and before the USPS was born. Negotiations and discussions between the Chief of Engineers and the Postmaster General continued for the next eighteen months while the transmutation of the Post Office Department into the U.S. Postal Service was carried out. The Postal Reorganization Act was passed by Congress on 12 August 1970, and on 26 September 1970 the Postmaster General requested the Secretary of the Army to provide assistance in real estate, design, and construction needed for the Postal Construction Program. While negotiations progressed towards the formulation of Memoranda of Agreement covering all postal construction, the Corps proceeded with assistance to the Postal Service on a project-by-project basis. Ultimately, the Corps participated in twelve such individual postal construction projects during 1970-1971, including post offices at Fort DeRussy, Hawaii, and Kearney, New Jersey, as well as a preferential mail facility at Memphis, Tennessee. These dozen projects can properly be considered as the genesis of the Corps of Engineers' participation in the Postal Service support mission that came in 1971.[5]

On 11 March 1971, the relationship between the Corps of Engineers and the U.S. Postal Service was formalized in two agreements. The first covered policies and general principles to prevail between the two agencies. It designated the Corps as Department of the Army spokesman and representative for all postal facilities and acquisition matters; it committed the Chief of Engineers to further development of working agreements; and it established the levels of responsibility. Under the provisions of this Memorandum, the Corps was granted substantial authority in the areas of real estate, design, construction, and contractual services. All funding was to come from Postal Service sources.[6]

A second Memorandum of Agreement of 11 March 1971 erected a formal Corps of Engineers organization to centrally manage and direct the Postal Support mission. This office, called the Corps of Engineers Postal Construction Support Office (CEPCSO), was formed on 26 May 1971 by Corps of Engineers General Orders No. 14. CEPCSO was located in Washington, D.C., as part of the Military Construction Directorate in the Office of the Chief of Engineers. As part of the Directorate, CEPCSO could utilize the existing expertise of the Directorate's divisions; organizationally, its Chief, Brig. Gen. George A. Rebh, was Assistant to the Chief of Engineers for Postal Construction Support. In October 1972, CEPCSO was upgraded to the status of a directorate, becoming the Directorate of Postal Construction (DPC). Its functions as head and heart of the Postal Support mission were largely unaffected by this change in title.[7]

At the outset, the cooperative agreements of 11 March 1971 projected a CEPSCO role in both the preferential and bulk mail facilities construction, but with the maturation of the Postal Service Regions in 1972, the USPS turned over development of the preferential system to its fifteen Regional headquarters. Thus for all intents and purposes the CEPCSO role (and later, that of Huntsville Division) in Postal Support came to be limited to the Bulk Mail Centers only.

In CEPCSO's (and later, DPC's) structure, there were four main divisions: Design, Mechanization, Project Management, and Projects, Planning, and Reports. This table of organization broadly reflected CEPCSO's two major duties in the Postal Support mission. It was to manage the Corps of Engineers' effort which would be implemented through the Corps' subordinate division and district organizations, and it was to provide an interface between the Corps and the USPS at the Washington level for the bulk and preferential mail systems. In the realm of facilities design, CEPCSO's role was less than comprehensive. In general, it administered only the design of the postal structures and their site adaption, because the USPS preferred to retain control over the design of the internal layout and mechanization portions of its facilities. In its turn, USPS independently contracted most of the equipment layout and design for the Medium Bulk Mail Centers to the AE firm of Kaiser Engineering and that of the Small BMC's to Giffels and Associates. One of CEPCSO's major tasks was coordination of the design

and erection of housing for Giffels' and Kaiser's equipment and flow system designs. Eventually, CEPCSO designated six, then later ten, Corps geographic districts to carry out the AE management functions for the BMC structures. Local districts likewise carried out real estate acquisition, site work, and award of construction contracts for the buildings in conjunction with CEPCSO and USPS authorities. CEPCSO also provided technical assistance, consultation, and review for the USPS in engineering, installing, testing, and maintaining its mechanized equipment. Finally, CEPCSO was responsible for managing the procurement of standardized Government Furnished Property to equip the BMC's.[8]

A centralized procurement of standard items had not originally been envisioned for the Postal Support effort. For the Large BMC's at New York and Chicago, at least, the design of equipment and the production of drawings and specifications were done with the intent to include them in the construction contract. The construction contractor would then obtain the necessary equipment for his project, have it delivered to the BMC site, and install it as part of his total operation.[9]

Careful consideration of the scope of the Medium and Small BMC program, however, rapidly eliminated any chance of continuing this practice. Since the construction of the nineteen remaining BMC's entailed an enormous volume of equipment, a policy that allowed the contractor to handle procurement on a job-by-job basis raised the undesirable prospect of nineteen firms competing for one Government requirement. Obviously, a centralized Government Furnished Property program was highly desirable under these circumstances.[10]

A shift to GFP and a centrally managed procurement generated several advantages, the most persuasive being the savings that would result from a large volume procurement of standard items. Competition among construction contractors in the open market would be eliminated and costs held down by preventing free bidding for scarce items from forcing up their prices. In addition, procurement could be made sufficiently in advance of the award of the construction contracts to have long lead time items promptly available at scheduled progress intervals when the construction contractor needed the material for installation. This benefit in turn would shorten construction time, a point that the USPS found very attractive in getting the BMC's into operation as soon as possible.[11]

Once the decision for centralization was taken, a Corps division had to be selected to manage the procurement program. Five Corps geographic divisions, along with the Huntsville Division, were initially considered as the most likely candidates for designation as the central procurement office; by August 1971 General Rebh, Assistant to the Chief of Engineers for Postal Construction, had settled upon Huntsville Division as the best choice.[12] On 6 August 1971, General Rebh wrote to the Deputy SAFEGUARD Systems Manager to explain the Postal mission and to solicit permission to use the Huntsville Division in carrying it out. During the first week of October 1971, General Rebh visited Huntsville to discuss Division participation in the Postal mission, and shortly thereafter it was unofficially announced that the Division had been chosen to make the Postal GFP procurement for CEPCSO. The arrangement was made official by a letter to the Division Engineer of 26 November 1971.[13]

According to the 26 November assignment letter, Huntsville Division was to act "as the central procurement office for the Corps of Engineers to accomplish the procurement of fixed mechanization components for the Postal Service Bulk Mail System."[14] It was estimated that about $200 million worth of equipment would be required for the nineteen BMC's remaining in the program. Though not specifically stated in the letter of 26 November, the Division was also expected to procure the sortation equipment for the Large BMC at Chicago.[15] As revealed in later exchanges or correspondence, Huntsville Division was also to assure destination and delivery schedules, deal with warranties and defects, carry out in-plant inspection for quality assurance, manage contract files, monitor shipping damage, and carry out financial administration and payment to GFP contractors. As might be gathered, this was a procurement mission par excellence, and relatively little was demanded from Huntsville's Engineering or Construction Divisions.[16]

In announcing Huntsville Division's participation in the Postal mission, General Rebh said, "The selection of the Division was based on the widespread experience, expertise, and splendid reputation earned under the GFP procurement for SAFEGUARD."[17] This was indeed a succinct summation of the outstanding qualities that had led to Huntsville's selection, qualities that General Rebh knew well from firsthand experience as the Division's deputy division engineer in 1968. From the ABM program, Huntsville Division had gained considerable proficiency in standardization and acquisition of technical-industrial equipment, as well as assuring that these items arrived in a timely manner at scattered locations.

Its current workforce needed little augmentation, and the engineering talent coexisting with procurement at Huntsville was second to none in the Corps of Engineers.

For these reasons, assigning the Postal Support procurement to Huntsville Division was a natural move, but it was also an assignment that conflicted with the Division's monogamous marriage to the ABM program. Accordingly, the Division's relationship with SAFSCOM had to be modified in order to permit assumption of the Postal mission. This was done in a landmark "Memorandum of Agreement" between the SAFEGUARD System Organization and the Chief of Engineers dated 22 November 1971.[18] The Memorandum defined the Division's first divergence from the ABM mission, and asserted that the SAFEGUARD System Manager concurred in this divergence, provided that "the exercise of the postal procurement responsibility. . .will not interfere with the accomplishment of the Division's SAFEGUARD mission, which is specifically understood to have first priority." Further, "this exception [to the SAFEGUARD mission] does not constitute a precedent for further modification of the status of the Huntsville Engineer Division as dedicated to the SAFEGUARD mission." Naturally, the Agreement also provided that funding and personnel spaces for the Postal mission would be generated solely for resources other than SAFEGUARD's.[19] Subsequent ER 10-1-22 Division regulations incorporated the provisions of this Memorandum in the Division's working constitution.[20]

When the Postal mission began in late 1971, the New York and Chicago Large BMC's were already underway. Some procurement opportunities remained for the Chicago installation, however, and even before receiving official confirmation of its role on 26 November, the Division commenced the Postal mission by awarding a contract for this Large BMC alone. A bid package for the procurement of sack and parcel sorting systems for Chicago was issued on 5 November. The package covered the procurement, fabrication, and delivery of new equipment for five tray-type parcel sorting machines, two sack sorting machines, and the performance of other work, including the furnishing of operating and maintenance instructions to postal employees, required manuals, spare parts, and equipment parts lists. Contract DACW87-72-C-9000, the first in the Postal mission, was awarded for the above items to Speaker Motion Systems, Inc., of Milwaukee, Wisconsin, on 11 January 1972. The award amount was $2,506,000.[21]

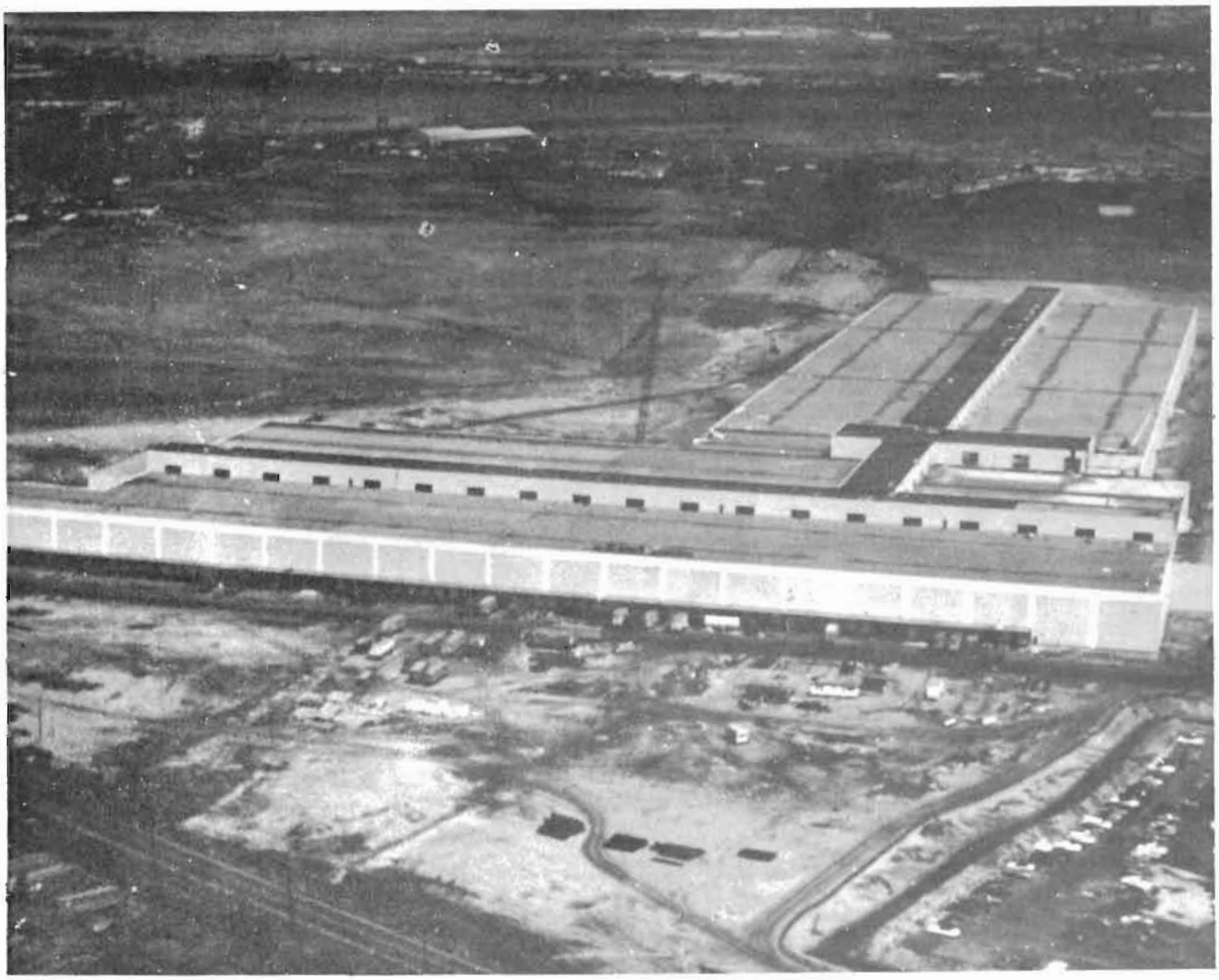
The award for the Chicago BMC in January 1972 was merely a warm-up for the vast Medium and Small BMC procurement that followed over the next four years. The quantity of material involved for these BMC's can only be described as immense. A partial listing included

--about 5,000 electric motors
--about 5,000 conveyor drives
--about 900,000 linear feet of belting
--53 sack shakeout units
--1,400 roller tables
--476 deflectors of three different types
--476 units of extendible conveyors
--632 units of metering rollers
--5,200 general conveyors
--174,000 square feet of slides
--44,500 chutes of five types
--3,800 container loaders
--42 container unloaders
--442 units of high speed parcel induction units
--19 computer systems

The total number of items to be purchased amounted to about two million; as noted earlier, the total value of these was initially estimated at about $200 million.[22]

The first step in the acquisition of the voluminous Medium and Small BMC procurement was to advertise it before prospective industrial suppliers and to publicize the procedures and conditions incumbent upon award winners. Towards this end a pre-solicitation briefing was held on 15 December 1971 in Washington, D.C. Notification of the briefing was widely circulated and 316 firms sent representatives to the meeting to hear presentations by General Rebh, Thor S. Anderson of the Huntsville Division, and officials of USPS. Attendees were provided with handouts describing a projected schedule for procurement, identification of procurement items, and other information relating to the bulk mail program.

Soon after launching the contracting process, the Division began to organize its resources for working administration of the Postal mission. In early 1972, Col. Henry K. Mattern was transferred to the Division's Executive Office as Special Assistant to the Division Engineer for Postal Activities. His duties included liaison with CEPCSO and assistance to the Division Engineer in Postal matters. Since the Postal mission was primarily a matter of procurement, the heaviest responsibility for execution fell to the Procurement and Supply Division headed by Thor S. Anderson. A veteran of more than twenty-five years in Government logistics, Anderson was also an "old-



ONE of 21 US Postal Service Bulk Mail Centers, designed by the Postal Service and constructed by Corps of Engineers Districts. Central procurement of fixed mechanization components (CFP) for the system was accomplished by the Huntsville Division.

timer" in the Huntsville Division, having joined during the formative SENTINEL period of 1967. The successful execution of the Division's GFP programs, both ABM and Postal, as well as later Saudi operations, were due in large measure to Anderson's experienced leadership. In 1971,early Postal activities were carried on by Anderson and the Procurement and Supply staff on an informal basis, but by 1 February 1972, a special two section Postal Branch had been set up with Roy E. Edwards as Acting Chief. Subsequent reorganizations in 1973 and 1974 produced a Postal Field Support Branch under Edwards and a Postal Contracts Branch under Benny G. Scott as Branch Chief. The Postal Contracts Branch had responsibility for bid solicitation, evaluation, contract award, and contract administration. The Postal Field Support Branch performed the GFP tracking function and served as the single GFP liaison point for the nineteen resident engineers in the field. The Postal Field Support Branch also handled the subscription mailing to prospective construction contractors for the BMC program. Both the GFP tracking and subscription mailing features of the Postal mission are described in more detail below. Staffing of the two Postal branches amounted to eighteen authorized civilian spaces, many of which were filled by internal transfer within the Division.[23]

The operations of Huntsville's procurement infrastructure were governed by the Armed Services Procurement Regulation (ASPR), the comprehensive multi-volume "bible" of approved Army purchasing procedures. In the case of the Postal BMC program, however, there was no precedent for a single division managing a centralized procurement of this magnitude for a civilian customer and one requiring interfaces with a number of other divisions and districts. Therefore, on 4 June 1973 OCE issued ER 1180-6-1, "Government Furnished Property for Postal Bulk Mail Centers," delineating responsibilities and procedures for inspecting, shipping, receiving, transferring, storing, and accounting for the GFP to be installed in BMC's. The regulation was applicable to all Corps of Engineers elements and field operating agencies in the BMC construction program.[24]

The procurement procedure for the BMC program was exceedingly complex. As noted above, the AE firms of Giffels and Associates and Kaiser Engineering under contract to the Postal Service had responsibility for designing the mechanization equipment that went into the BMC structures. While the Postal Service retained the total design responsibility, the Corps did the same for the procurement. While not actually designing the BMC equipment, CEPCSO's Mechanization Division coordinated drawings and specifications for the procurement of the GFP, reviewed mechanization designs and specifications, and supervised the integration of mechanization designs with building designs. In line with these operations, CEPCSO acted as the originating agency for Huntsville's GFP procurement packages. Working in conjunction with the AE firms of Giffels and Kaiser, CEPCSO furnished Huntsville Division with a list of articles to be procured, their quantities, the authorization to procure, item specifications, delivery dates and locations, data requirements, cost estimates, and necessary funds to accomplish the procurement.

The first and by far the greatest part of the GFP procurement for Medium and Small BMC's accompanied CEPCSO's assignment of the procurement mission to Huntsville Division in late 1971. This huge initial "shopping list" encompassed about twenty basic equipment items: various kinds of sack sorters, loaders, conveyors, shakeout units, sack holders, belting, motors and drives, slides, deflectors, computer systems, and so forth. Later, these twenty basic items were expanded to twenty-seven items comprising over two million deliverable articles. The twenty-seven items were broken down into ninety-six contract packages so that multiple awards might be made. This was done to avoid overloading any one supplier so that timely delivery could better be assured.[25]

Award of the contracts comprising the GFP for Medium and Small BMC's was spread over twelve months from 17 July 1972 until 29 June 1973, with several follow-on contracts extending to 5 December 1975. Most of the contracts after June 1973 were for miscellaneous additional items, quantities, or spares. The first Postal GFP award for Medium or Small BMC's was made on 17 July 1972 to Dyna Corporation, Dayton, Ohio. Under the provisions of this contract, Dyna Corporation was to supply the USPS facilities with four one-horsepower and thirty twenty-horsepower conveyor drive electric motors worth $4,100. The second Postal GFP contract was substantially larger: on 29 August 1972, the Ohio Rubber Co., Willoughby, Ohio, contracted to supply 56,075 ten-inch synthetic rubber impact cones molded around a steel insert bearing for $217,000. Over the ensuing weeks and months, ninety-four other Postal contract awards were made on an almost weekly basis, with most bid openings being conducted in the lobby of the SAFEGUARD Building Annex in Huntsville.[26]

Supervision of the flow of GFP items from factory to delivery site was an immense task performed by the Postal Area Support Branch under the term "GFP tracking." At the production end of the supply chain, each GFP contract required the supplier to submit an original production work schedule, monthly updates, and reports on the status of the contract. These schedules were reviewed, monitored, and administered for Thor S. Anderson, the Division's Contracting Officer in Postal affairs, by the Postal Area Support Branch. The supplier-furnished information became input into the data bank of a computer controlled inventory system, along with entries for delivery dates and locations. The automatic data processing software used for Postal activities was directly modified from that employed for SAFEGUARD's GFP inventory. Thus on short notice, at any time it was possible to ascertain the status of any GFP contract that had been awarded since the beginning of the program. In practice, the "tracking" function entailed frequent telephone conversations and plant visits to sort out production bottlenecks, damage or loss in transit, and proper transfer to the construction contractor at each site. It should be noted that quality control on the manufacturer's premises prior to shipment was delegated to personnel of the Defense Contracts

Administration Services (DCAS) acting in a procurement quality assurance role. Reimbursement to DCAS was on the basis of .47 manhours of effort per thousand dollars of contract value.[27]

The GFP delivery dates were specified by CEPCSO simultaneously with the original procurement requirement and authorization. The GFP supply contract delivery date was, in fact, a thirty-day "window" consisting of an early date ("not to be delivered earlier than") and a late date ("not to be delivered later than). There existed, in most cases, a thirty-day span between the supply contract late-date and the construction contract late-date. The latitude was provided as a cushion to insure that the GFP would be received at the construction contract site well before its moment of need, to minimize interference with construction schedules due to late deliveries, damage, or other unforeseen problems.

At the delivery end of the supply chain, "tracking" required the verification of prompt and safe delivery of GFP material at any given site. In the case of the Postal program, this was done by the Resident Engineer or his authorized assistant at the construction site. Upon the recommendation of the local District Engineer, Huntsville Division designated the Resident Engineer as Contracting Officer's Representative (COR) to administer GFP field actions. In the event of inexcusable untimely delivery of equipment, the GFP contracts called for assessment of actual damages rather than liquidate damages against the supplier. This provision was included to encourage supplier to make timely delivery because of the magnitude of financial damages that the USPS would suffer if the bulk mail network did not go into operation when scheduled.[28]

Not surprisingly, the Postal GFP procurement encountered several snags as it matured. A large percentage of GFP was delivered late when compared with the original contract delivery date. The percentage of GFP delivered late **contractually,** however, was approximately one percent. This figure included the effect of excusable delay factors, such as the impact of USPS-AE design deficiencies and continuous technical changes. As an example of the technical changes, the five general and incoming conveyor contracts for items critical to the mechanization system showed an average of approximately 100 changes per month for almost eighteen months; in October 1973, 27 percent of the original contract drawings had been revised, which necessitated 416 modifications to fifty-five contractors. This trend continued throughout a major portion of the program. Additionally, in some sectors such as the conveyor and rubber belting industries, the huge sudden demand of the BMC program stressed or exceeded the capacity of specialized manufacturers, leading to rather less output than USPS originally expected. Other delays stemming from "acts of God" or acts of man--accidents, strikes, breakage or loss in transit, improper handling or storage, weather conditions, and material shortages-- were common to any procurement and had no exceptional impact on Postal GFP.[29]

In addition to fulfilling the "GFP tracking" function in procurement, the Postal Area Support Branch was also charged with a major task in supporting the Postal BMC construction bidding process. This responsibility, which was quite separate from the procurement operations of the Branch, involved supplying diverse USPS authorities, Corps geographic districts, and especially prospective construction contractors with certain mechanization equipment drawings and specifications available at Huntsville Division. In carrying out this assignment, Postal Area Support Branch Chief Roy Edwards developed the concept of "subscription mailing" which became one of the most notable innovations of the Procurement and Supply Division's Postal activities.[30]

At the prompting of the Postal equipment AE design firms Giffels and Kaiser, OCE decided that one agency should control all of the mylar master mechanization equipment drawings for BMC's. This unity, it was thought, would ease control of ensuing modifications and also expedite distribution of copies to elements that needed them. Because CEPCSO was already handling the review of equipment design, it might seem logical that the mylar masters should have remainded under Washington's control. However, CEPCSO lacked the sheer capacity or experience to duplicate, mail out, and continually update the mass of drawings associated with the program. Huntsville Division, on the other hand, possessed all these qualities because of SAFEGUARD. Also, as managing office for the GFP procurement, Huntsville Division already had possession of the written equipment specifications which were included as Section "F" of each GFP contract. For these reasons, under OCE Engineering Circular EC 1180-6-4, Huntsville Division was made the "office of record" repository for custody, reproduction, and issuance of the mylar master equipment drawings, installation drawings, and specifications associated with GFP

equipment.[31]

By the time that "subscription mailing" fully matured, Huntsville Division was controlling and issuing four categories of GFP-related materials; standard mechanization equipment drawings, standard mechanization installation drawings, site peculiar mechanization equipment drawings, and mechanization equipment specifications. These documents served several purposes. In procurement the GFP equipment drawings and specifications served to guide contracting, manufacture, and assembly of components. But in addition to their procurement and manufacture role, the mechanization drawings and specifications were also vital to the construction bidding, erection, and construction supervision process. Only with the help of GFP drawings and specifications could an architechtural AE firm present a building design proposal. Only with GFP drawings and specifications in hand could a prospective construction bidder derive the structural configurations, finishing instructions, and what hardware was not provided as GFP. A host of placement, installation, and interface data came from the installation drawings. These drawings and specifications were equally essential to Corps district personnel in the resident engineer offices who had to oversee the construction process after contract award.

"Subscription mailing" was Huntsville Divison's answer to the need to distribue the GFP drawings, installation drawings, and specifications to nineteen districts and more than one hundred construction firms interested in building BMC's. At the heart of the "subscription mailing" system was a series of mailing address lists maintained in the Postal Area Support Branch made up of those construction firms and official agencies that wished to obtain drawings and specifications. As BMC IFB's were issued site-by-site, construction bidders were advised through notices in the construction solicitation that they might obtain needed GFP drawings and specifications from Huntsville Division, together with the costs. Upon receipt of a request from a bidder, the firm's name was entered on a "subscription mailing" list to immediately receive a complete up-to-date set of standard drawings, the site peculiar drawings applicable to its need, and one set of associated specifications. Later, as modifications flowed in from Washington, revised drawings incorporating changes went out to all those entered on the lists. Once a firm or agency was entered on the "subscription mailing" list for a particular set of drawings, that entry would be in a position (drawing-wise, at least) to competitively bid on all subsequent BMC's.

The fees established for "subscription mailing" were modest and were never intended to defray reproduction costs. A subscription for installation drawings could be had for $100; a subscription to standard equipment drawings ran $150; a set of site peculiar drawings and associated specifications were $15. Total costs for the subscription mailing for the Small and Medium BMC's was $441,816.00, excluding small costs for the Washington BMC which was handled separately.[32] In addition to construction firms with paid subscriptions, the Huntsville Division also mailed out large quantities of "freebie" drawings to Corps districts, structural AE firms, and various USPS authorities. In the spring of 1978 Roy Edwards personally estimated to the author a tentative "ballpark" figure of about 400 tons total weight for all mailings. Careful tailoring of the reproduction to quantities required resulted in less than 5 percent surplus after the mailing terminated.[33]

At the inception of the BMC program, drawings, for the Chicago Large BMC were handled on an ad hoc basis by Intra-Army Directives from Washington to Huntsville Division rather than on a subscription basis. A policy of "subscription mailing" was instituted with the Washington, D.C., BMC and evolved through three phases. The Washington BMC was the progenitor of the nineteen BMC's and was treated separately because there was a time span of ninety days between it and the next BMC IFB for Atlanta. The second phase was "subscription mailing" for the remaining thirteen Small BMC's, and the third was for the five Medium BMC's.

Because of delay in final design by the AE, Huntsville was compelled to issue standard equipment drawings and specifications for the Washington facility that were incomplete or outdated. They were issued in a deficient state so that construction bidders would have something, however inadequate, on which to base their proposals. The Washington "subscription mailing" did not contain the standard installation drawings or the site peculiar installation drawings.

Mailing for the remaining Small BMC's, although more complete, was still inadequate in some areas because the design of GFP components had not yet been formalized. The later the bid opening for a particular BMC the more complete the drawings became. Data for the Small BMC phase consisted of standard mechanization equipment drawings, standard mechanization installation drawings, site peculiar mechanization drawings, and mechanization equipment specifications.

The mailings for the five Medium BMC's of the last

phase differed from the above in that the standard mechanization installation drawings for the five centers were site peculiar. Since the five Medium BMC installations were not de facto standard, each geographic district bidding a BMC controlled the mylars and reproduced them to support their individual bid initiation. Huntsville supplied only standard mechanization equipment drawings, site peculiar mechanization drawings, and equipment specifications for the Medium centers.[34]

Because of contractual ramifications involving the drawings under "subscription mailing," Huntsville Division maintained detailed records to establish the exact level of amendment existing in the GFP drawings and specification sheets at the point of construction contract award. These records covered all mailings, and the Division could trace each drawing and specificiation sheet to find the revision level, amendment level, modification level, date of mailing, and identification of those who received the mailings. This degree of record-keeping substantiated the Government's legal position so soundly that no contractor chose to contest claims on the basis of obsolete information supplied by GFP drawings or specifications. The Division, of course, was not responsible for design errors or inconsistencies upon which some claims might have been based.[35]

As in SAFEGAURD, there was a special "after action" report prepared within Huntsville Division concerning the Postal mission. This report contained a section entitled "Lessons Learned." One of the most significant lessons learned was that the planned procurement and production lead-time and determination of the requirements of GFP must be adhered to and furnished to the procuring agency within the announced schedule. The failure to do so could result in stretch-out of the overall program. Technical problems, increased costs, and delinquent deliveries can also be anticipated as forced trade-offs for compressing production and/or procurement lead-time.[36]

An old saying has it that "the proof of the pudding is in the eating." The best proof of the quality of the GFP procurement program could be found in the timely delivery of GFP and in the cost advantages accruing to the USPS when the "bottom line" was calculated. Original estimates for the mechanization equipment had been in the vicinity of $200 million, but final GFP contract awards, including all modifications, at the time of close-out totalled less than $173 million, despite continuing inflationary tendencies of the period.[37] Furthermore, after auditing the procedures used by Huntsville Division during 1973--by which time sixty contracts worth $141,529,805 had been issued--the U.S. General Accounting Office concluded:

> HND had adopted a good management approach for the postal GFP procurement. Because of the tight schedules and the massive coordination required, the normal management by exception probably would not have been successful. The procedures and controls adopted to monitor the performance of the contractors are good.
>
> Although some cost growth has occurred, the cost increases have, for the most part, been caused by design changes, which were beyond HND's control. The procurement method of primarily advertised fixed price contracting and dividing large procurements among several contractors based on contractor capability and bid price was good. Bidder response seemed adequate in most cases. In those cases where bidder response was lacking, HND took appropriate steps to increase bidder response.
>
> The late receipt of design packages [noted above, "Lessons Learned"] and many contract supplements appear to have contributed to delivery delays. However, delays do not appear to be significant at this time, with the exception of conveyors and chutes. These items are being delayed for a variety of reasons, many of which appear to be beyond the control of HND. . . .
>
> The lines of communication between HND, COE [sic, OCE], and USPS appear to be effective. Coordination and cooperation seem to be good, and all parties to the procurement appear to be kept informed on the status of the procurement.
>
> In summary, although some minor cost growth and schedule slippage have occurred, at this point, HND appears to have managed the postal GFP procurement well.[38]

II. The NASA Space Shuttle Mission and Other NASA Projects

In May 1972 Huntsville Division assumed the second of its missions beyond the SAFEGUARD System, a commitment to support the National Aeronautics and Space Administration (NASA) through design and construction of test facilities needed for the Space Shuttle. The agreement with NASA subsequently evolved into a four year program including about fifteen Space Shuttle engineering

design and construction contracts worth about $30 million. After the Space Shuttle projects got underway, the Division also performed several smaller miscellaneous tasks for NASA that were not directly related to the Shuttle, such as storm damage repairs to the Marshall Space Flight Center Headquarters Building on Redstone Arsenal. Though less imposing in engineering terms than SAFEGUARD and less significant financially than the Postal procurement, the Division's NASA-related activities still represent a notable part of the Division's work load during the period 1972-1976.

When Huntsville Division joined the Space Shuttle effort in May 1972, the program was already two years old. Early in 1970, NASA's Office of Manned Space Flight had turned its attention to realizing the design and development of a large payload manned spacecraft that could economically serve as a cargo carrier for Earth orbit missions during the 1980's. The chief criteria for the craft that came to be dubbed the "Space Shuttle" were a large useful payload, low operating costs, and ultra-reliable flight characteristics. The vision was that of a veritable space cargo truck capable of making repeated shuttle trips back and forth into orbit. As President Nixon expressed it when authorizing a Shuttle "go-ahead" on 5 January 1972,

> this system will center on a space vehicle that can shuttle repeatedly from Earth to orbit and back. It will revolutionize transportation into near space, by routinizing it. It will take the astronomical costs out of astronautics. In short, it will go a long way toward delivering the rich benefits of practical space utilization and the valuable spinoffs from space efforts into the daily lives of Americans and all people.[1]

The "rich benefits" mentioned by the President were astounding. They included the ability to recover, repair, and adjust the paths of satellites already in orbit; to take a quantum jump forward in the number, weight, and complexity of orbiting experiments; to make possible exotic manufacturing in a space environment; to obtain a ready rescue capability for endangered astronauts; to enable the assembly of the first permanent manned space stations from components brought up in stages.

As President Nixon announced the program, NASA engineers were busy making the vehicle a reality. On 26 July 1972, North American Rockwell Corporation's Space Division at Downey, California, was chosen as prime contractor for design, development, and production of the Orbiter Vehicle and its integration with other elements of the Shuttle system. As it has emerged from North American drawing boards, the Space Shuttle configuration is that of a delta-winged, fat-bodied cross between a rocket and an airplane about the size of a DC-9 airliner. Incorporated into the tail of the Orbiter Vehicle itself are three Rocketdyne Space Shuttle Main Engines (SSME) generating 470,000 pounds of thrust each; during the launch phase these engines are fed liquid hydrogen (LH^2) and liquid oxygen (LOX) from a single simple cylindrical External Tank half again as long as the Orbiter itself. Having supplied the "piggy-back" Orbiter engines from lift-off into orbit, the External Tank is jettisoned to fall free while the Orbiter continues its space mission.[2]

Despite their total thrust of 1,410,000 pounds, the Shuttle's liquid rocket engines are totally incapable of lifting the vehicle's weight without assistance. Most of the boost effort during the launch phase is made by the two Solid Rocket Boosters (SRB) manufactured by Thiokol which, at 3,521,000 pounds of thrust each, are the largest such solid rocket motors ever made. The motors are attached to the flanks of the External Tank underneath the Shuttle and are cast off after burn-out to be parachuted back for reuse.[3]

As prime contractor, North American Rockwell was responsbile for testing the Orbiter Vehicle's airframe and flight characteristics in conjunction with NASA. NASA's Marshall Space Flight Center (MSFC) at Huntsville was charged with partial or complete testing of the Orbiter's liquid fuel SSME, the External Tank, and the SRB. The Orbiter's liquid fuel engines were to be test-fired at NASA's National Space Technology Laboratory (NSTL)[4] at Bay St. Louis, Mississippi, an isolated location about twenty miles inland on the Pearl River that had previously seen comprehensive engine tests for the earlier Saturn series of rocket engines. Structural tests on the Shuttle's External Tank and on the SRB were to be performed at the MSFC. These structural tests meant anchoring the test articles in specially-designed test stands and subjecting them to simulations of the static and dynamic stresses that they would encounter in actual use.

In testing components of the Shuttle, NASA determined that the most economical approach would be to modify existing facilities such as the former Saturn engine stands standing idle at Bay St. Louis rather than to build new facilities. Assistance in technical design and construction of these modifications was a natural mission for the Army Corps of Engineers in general and for Huntsville Division in particular. The Division was experienced

in missile work for the SAFEGUARD System and conveniently collocated with the MSFC in Huntsville; many Division employees had also participated in the design and construction of the original Saturn facilities at both MSFC and NSTL as members of Mobile District. Informal converstions for a NASA mission were conducted during the spring of 1972, and cementing of the NASA-Corps connection was officially announced in May 1972. Written concurrence of the SAFEGUARD System Organization releasing Huntsville Division for support of the Space Shuttle came in a "Memorandum of Agreement" dated 8 June 1972. As with the Postal procurement agreement with SAFSO in November 1971, the NASA mission Memorandum also stipulated that for operational control the "Space Shuttle Program responsibilities are exceptions to the provisions of existing agreements between the Chief of Engineers and the SAFEGUARD System Manager... [which] do not constitute a precedent for further modification of the status of the Huntsville Engineer Division as dedicated to the SAFEGUARD mission."[5]

Organizational accommodations for the conduct of the NASA mission were relatively simple. Shortly after assumption of the mission in May 1972, Lt. Col. J.J. Cook was assigned to the Executive Office as a Special Assistant to the Division Engineer for NASA Activities. Joe G. Higgs, former Site Development Section Chief, Civil Engineering Branch, Engineering Division, was made NASA Project Manager. By the end of 1972, Higgs headed a one-man NASA Project Office under the Project Management Branch of the Engineering Division. During 1973 the NASA Project Office grew to two, and Higgs was succeeded by C.R. Thomas as Section Chief. The Project Office monitored criteria development and final design and provided technical supervision of construction contract packages. Engineering support and management for construction came under a three-man NASA Construction Office in the Construction Division that was physically located in Bldg. 4371 at the MSFC. Everitt W. Martin became Chief of the NASA Construction Office in 1973. Since the NASA work was predominantly engineering design and construction, no special organizational changes were warranted in other Division offices.[6]

Because extensive contruction was anticipated at the NSTL, along with some lesser activity at the nearby Michoud Assembly Facility outside New Orleans, a joint area office with a staff of about a dozen was opened at NSTL on 17 November 1972. Personnel assigned commuted to supervise jobs at both the NSTL and at Michoud. The first Area Engineer was John J. Blake, formerly Resident Engineer at the Grand Forks, North Dakota, SAFEGUARD MSR site, who served until July 1973. Blake was succeeded by W.F. Jebb on 25 November 1973; Jebb was followed by E.L. Taylor on 23 June 1974. Construction activities at the MSFC in Huntsville were supervised directly by NASA Construction Office located on Redstone Arsenal but organizationally attached to the home office.[7] The tasks undertaken at each of these three locations provided a convenient framework for describing Huntsville Division's NASA mission, and the **History** will briefly consider in turn Corps activities at the NSTL, followed by Michoud and the MSFC.

At the NSTL, Huntsville Division worked closely with NASA between 1972 and 1976 on four major construction contracts totalling about $16.5 million. Here, on an isolated Government reservation in the Pearl River Swamp, NASA wished to modify three existing test stands remaining from the Saturn program for test firing of the Space Shuttle Main Engines (SSME). Two of the stands designed A-1 and A-2 were old Saturn II facilities to be modified for single engine tests of the reusable LH_2-LOX fueled SSME. Stand A-1 was intended to simulate low altitude flight conditions and Stand A-2 to simulate high altitude flight, the high altitude Stand A-2 differing from its companion in that the engine was to be mounted at an angle of 18 degrees from the vertical and by the addition of a diffuser system through which the engine exhausts. The diffuser system serves to reduce back pressure, thereby imitating the operating conditions found at about 70,000 feet. The third structure, Test Stand B-2, was an old Saturn S-IC facility formerly used for acceptance testing; as Phase I of two contracts used for acceptance testing; as Phase I of two contracts, NASA wanted to convert this stand to accept a cluster of all three SSME in their final Orbiter configuration. Under a separate Phase II contract, modifications to Test Stand B-2 also included construction of off-site docking facilities and a turning basin to handle the barges carrying LH^2 and LOX.

NASA and Huntsville Division began NSTL work by contracting the modifications to Stands A-1 and A-2 needed early in the SSME testing program. For Test Stand A-1, NASA had already contracted with the AE firm of Sverdrup & Parcel & Associates, St. Louis, Missouri, for design engineering of the modifications, and Huntsville had only to monitor this contract. Actual construction at Bay St. Louis was begun by the issuance of an IFB for modifications to Stand A-1 on 16 August 1972. Distribution of this IFB included 166 sets of drawings and 196 sets of specifications mailed

to seventeen prequalified prime contractors. At the bid opening in Huntsville's Sheraton Motor Inn on 26 September, Industrial Contractors, Inc., Idaho Falls, Idaho, was found to have the lowest of nine bids received. Contract DACA87-73-C-9002 in the amount of $2,942,949 was subsequently awarded to Industrial Contractors on 16 October 1972.[8]

Under the terms of their contract, Industrial Contractors were to extensively modify the existing stand, along with its piping and work platforms, to accept one SSME in a vertical firing position. New vacuum-jacketed LH^2 and LOX tanks, oxidizer tanks, thrust measuring systems, new controls and bay equipment to monitor engine performance were to be installed. New fire extinguishers, flame deflectors, and repainting rounded out the revisions. The project was due for completion by 22 November 1974, and it was accepted by NASA on that date. The final cost, after fifty-seven revisions to the original contract, was $3,616,793.[9]

Remodelling of companion Test Stand A-2 followed about eight months after Stand A-1. In fact, the first NASA contract awarded by the Division, DACA87-73-C-9001, went to Sverdrup & Parcel for AE services on Test Stand A-2 on 29 September 1972, or two weeks before the construction contract award for Stand A-1.[10] A construction contract for Stand A-2 work was awarded to Industrial Contractors on 22 June 1973. Originally worth $4,169,699, this contract ultimately grew to $4,265,355 by the time of acceptance on 8 July 1975. Construction changes were similar to Stand A-1 except for the addition of a diffuser which moved the engine, propellant tanks, and other equipment upward about eight feet.[11]

As part of their contracts for Stands A-1 and A-2, Industrial Contractors were expected to supply the materials installed in the course of construction. A notable exception, however, was made for the vacuum-jacketed, stainless steel 110,000 gallon LH^2 and 40,000 gallon LOX fuel tanks that represented the most significant items on the modification agenda. These tanks were expensive, sophisticated, long-lead procurement items, and NASA preferred to retain control of their design and supply through its own GFP contracting. Accordingly, NASA awarded contract NAS8-29323 in the amount of $1,058,880 for Test Stand A-1 tanks to Pittsburg-Des Moines Co. on 25 October 1972; the contract was then released to Huntsville Division for further supervision. Under Division management, a contract option was exercised during FY 1973 for a second set of tanks for Stand A-2, thus bringing the total for contract NAS8-29323 to slightly more than $2 million.[12]

The third test stand to undergo modification at Bay St. Louis, Test Stand B-2, was a structure intended for the later stages of the SSME testing program when the final configuration of three coupled engines was to be fired. Hence, contracting for Test Stand B-2 came later than for Stands A-1 and A-2; it did not get underway, in fact, before early 1974. The operations performed on Stand B-2 were also more far-reaching than for either A-1 or A-2. In addition to modifying the Test Stand proper, NASA also wanted to enlarge the barge turning basin terminal at the foot of the stand and to build docking facilities for the unloading of the cryogenic liquid propellants. The disparate nature of the work, along with scheduling and other considerations, prompted separate Phase I and Phase II construction contracts. The design engineering, however, for both Phase I and II was done under a single AE contract (DACA87-74-C-9001) with Sverdrup & Parcel for $109,314.[13]

Since it was less prone to construction snags and was needed to facilitate incoming water-borne shipments of large pieces for remodelling the test stand, the off-stand Phase I was undertaken first. A contract for Phase I (DACA87-74-C-9002) in the amount of $1,988,000 was awarded to Algernon Blair Industrial Contractors, Inc., of Atlanta, Georgia, on 7 February 1974. It was completed on 6 September 1975. An interesting feature of Algernon Blair's approach was the election to build the docking facilities on dry land, then to enlarge the canal basin by dredging material away from the dock and surrounding areas.[14]

Modifications to Stand B-2 itself were started on 18 October 1974, when Industrial Contractors, Inc., were awarded their construction contract at the NSTL. The contract, DACA87-75-C-9003, was worth $7,429,069, making it by far the largest in the test stand series. The substantial sum was warranted by the extensive structural revisions required to accommodate the Main Propulsion Test Article (MPTA), comprised of three flight-rated SSME in their final Orbiter configuration, a structural truss simulating the Orbiter Vehicle, and an External Tank. Industrial Contractors was to remove the entire upper 100 foot superstructure of the test stand above the existing booster support frame, along with a portion of the existing booster support frame. These areas were completely rebuilt to the new configuration required for the MPTA. Unlike Stands A-1 and A-2 which incorporated fuel tanks in the course of modification, the LH^2 and LOX supply for MPTA runs on Stand B-2 came from an actual Shuttle External Tank mounted on the Stand as it would be on

the flying Shuttle.[15]

TEST STAND B2, "Main Propulsion Test Article" stand extensively remodeled at NSTL.

In carrying out the engine stand modifications, Industrial Contractors made extensive use of off-site fabrication procedures. The existing canal channel from the Pearl River to the foot of the stands made water transport of the heavy prefabricated components convenient and economical. Thus off-site fabrication enabled large structural members to be completely assembled many miles away, floated to the job site by barge, and lifted directly into position on the test stand as complete units. Hoisting equipment presented no great obstacle, since the construction contract allowed the contractor to utilize existing derricks mounted on top of the stands. These cranes provided capacity to lift and set one-piece structural sections weighing up to 200 tons. Piping, ladders, platforms, and miscellaneous fittings not already installed on the structural sections at the fabricator's shop could be installed on the ground beside the stand before the piece was lifted into place. Major lifts often required planning several weeks in advance of the lift because of complicated rigging, narrow clearances, and so forth.

The prefabricated approach was not without its difficulties. One that could have been anticipated was that the complex prefab components did not always fit into the places intended for them. Adjustments had to be made before the components could be mated. The situation was further compounded by NASA subcontractors performing maintenance and refurbishment in the same general area as the new construction, leading to a need to coordinate activities in the interests of efficiency and safety. Finally, as engine development continued apace, test criteria changed, producing subsequent contract modifications. The modifications produced little real delay in completion, however, and all the engine stands were ready when needed, even though this was four months early in the case of Stand A-1 and six months early for Stand A-2. The A-1 Stand went into operation on 19 May 1975 with the first NSTL firing of the SSME; Stand A-2 saw its first Shuttle test firing on 31 March 1976; tests on Stand B-2 were schedule to begin in December 1977.[16]

At Chalmette, Louisiana, thirty-five miles southwest of the NSTL, lies NASA's Michoud Assembly Facility, a collection of cavernous buildings used during the Saturn program for assembly of huge stage components. As part of the Shuttle program, NASA desired to resurrect the facility for production of the 206-foot long External Tank. This need entailed a revamping of parts of the Facility. The majority of these activities were carried out under NASA-administered contracts and are of no concern here, but Huntsville Division was requested to design and construct the modification and rehabilitation of the air conditioning and dehumidification system for the main fabrication building. Design of the air processing system changes was awarded to the New Orleans AE firm of Cappel, Tousley & Moses under contract DACA87-73-C-9004 on 29 December 1972. Construction began on 29 June 1973 under a $529,480 contract (DACA87-73-C-9004) awarded to Babst Services, Inc., Metairie, Louisana. Corps contract supervision for the Babst contract was performed from the Bay St. Louis Area Office; the modifications were completed on 1 September 1974 and accepted by NASA on 10 October 1974.[17]

The third focus of Huntsville Division's NASA-related activites was the Marshall Space Flight Center on Redstone Arsenal at Huntsville. The MSFC was the original home of the American space program, and despite dispersion to Houston and Mississippi, in the mid-1970's it still remained NASA's single most important test complex. NASA planned to utilize existing MSFC facilities for most of the structual testing of the Shuttle's Enternal Tank, its SRB motors,

and of a complete Shuttle vehicle assembly in flight configuration. As at the NSTL, this most economical of test program options still required considerable remodelling, refurbishing, and some new building. At the MSFC, therefore, Huntsville Division carried out five important Shuttle test facility construction projects worth about $10,000,000 between 1973 and 1976. Additionally, during the same period the Division managed three other contracts for NASA that were not related to the Shuttle program. These three non-Shuttle projects offer considerable interest of their own and will be described following the Shuttle facilities.

Of the five Shuttle-related projects conducted by Huntsville Division at the MSFC, the first two can conveniently be grouped together by virtue of their chronology and nature. Both projects came early in the NASA mission -- the construction contracts in February 1973--and neither project was concerned with the Shuttle structural test facilities that were built much later. The first NASA-Huntsville Division undertaking at the MSFC was a result of NASA's need to obtain acoustical parameters for the SSME before the main series of developmental tests were run. NASA believed it could derive the information sought by extrapolation through a series of 1:40 scale model engine tests. A test facility for operation of the small engine already existed in the Acoustic Model Engine Test Facility (MSFC Bldg. 4540), but modifications were needed to accommodate the subscale SSME. For this job, NASA engaged the AE firm of H.J. Ross to design the modifications while handing over construction contract responsibilities to Huntsville Division. On 6 February 1973, the Division awarded construction contract DACA87-73-C-9005 for $1,969,269 to Industrial Contractors, Idaho Falls, Idaho, the lowest of ten bidders. Over the next eighteen months, Industrial Contractors revised the Acoustic Model Engine Test Facility's structure and installed new gaseous hydrogen and nitrogen pressure systems, a LH^2 system, and various ancillary support systems. Subsequent to the initial February 1973 award, a major Change Order "BO" was appended for work on Bldg. 4659, the High Pressure Gaseous Propulsion System Support Building. This change order called for construction of a compressor building, vaporization shed and burn stack, and several hundred yards of pipeline connecting the compressor building and test stand. After Change Order "BO" and twenty others worth an additional $1,088,947, the Acoustic Model modifications were accepted by NASA on 6 August 1974.[18]

Concurrent with the Acoustic Model Engine Test Facility project, Huntsville Division also awarded and administered a NASA-designed addition to the MSFC Hazardous Operations Building housing the Electrical Power Laboratory. The addition provided laboratory space for research, development, and evaluation of electrical power generation devices and integration of electrical systems associated with the Space Shuttle program. This project, contracted to Bryson Construction Co. of Decatur, Alabama on 20 February 1973, had an original award value of $268,400. During the ten month construction period, Bryson Construction added a 6,500 square foot concrete masonry addition complete with air conditioning, heating, and power to the existing Hazardous Operations Building. The addition was accepted on 24 January 1974.[19]

More than eleven months elapsed during 1974 between completion of the Electrical Laboratory Addition and the commencement of further Corps-directed Shuttle construction at the MSFC. During this period, the Division was engaged in two non-Shuttle tasks that will be described later: installation of a chiller system in Bldg. 4487 and repairs to Bldg. 4200. When Huntsville Division resumed Shuttle-related construction at the Center, it was on a series of three kindred projects intended for the Shuttle's structual testing program. With a total original contract value of about $6,842,000, these three corstruction contracts represented a large chunk of the Division's NASA mission.

It will be recalled that the Space Shuttle's External Tank performed highly important dual functions in fueling the Orbiter's three SSME as well as tying the Orbiter and the two SRB motors together. This "piggy-back" configuration imposes great static loading of the External Tank from the time the SRB motors, Orbiter, and Tank are mated through the roll-out to the launch pad and especially during the launch phase of the mission. These static loads are compounded by the aerodynamic forces and bending moments acting on the Shuttle in the ascent of the flight until the External Tank is released from the Orbiter after attaining orbit. These factors, coupled with the stringent requirement for minimum weight, dictated the need for a careful ground structural test program.

The External Tank consists of three major elements: a LH^2 tank, a LOX tank, and an intertank structure joining the two. The Structures and Mechanics Laboratory at the MSFC, modified in FY 1973 to accommodate the testing of major Shuttle components, was adequate and could be used for structural testing of the LOX tank and intertank

structure. Because of its size (approximately twenty-six feet in diameter, 113 feet long) and because NASA intended to test the tank filled with 53,800 cubic feet of LH^2, the vessel requires a very large test facility with a suitably removed location. An existing ten-year old Saturn S-IC stage engine test stand (Bldg. 4670) could, with modifications, provide the capability to test the LH^2 tank.

During 1973 NASA engaged the AE firm of Norman Engineering to design the conversion of the Saturn engine stand into a structural test facility, and in 1974 the Agency turned to the Huntsville Division to conduct the construction phase. IFB's for the job were issued to eight prequalified firms on 8 August 1974; three bids were received with Algernon Blair Industrial Contractors, Inc., Atlanta, Georgia, the low bidder. On 4 November 1974 contract DACA87-75-C-9004 in the amount of $3,821,000 was awarded for External Tank modification to the S-IC stand. Algernon Blair's primary responsibilities included relocating the stand's flame deflector, augmenting the adjacent LH^2 storage capacity, installation of LH^2 transfer and disposal systems, modification and rehabilitation of the high pressure gaseous and water systems, modification to the service platforms and structural members, modifications to and extension of the electrical and mechanical utilities, and procurement and installation of hydrogen instrumentation and control system in the Test Control Center and on the stand. After thirty contract changes worth an additional $229,213, the facility was accepted by NASA on 9 July 1976. The non-delivery of stainless steel vacuum-jacketed pipe delayed completion by about ten weeks.[20]

Just as the External Tank required a structural test program to verify its design criteria, so too did the SRB motors. Not only did these have to resist a generated thrust of 3,500,00 pounds, but the casings were expected to survive a useful life of ten firings, including parachute descents from the upper atmosphere and subsequent recovery operations. As with other aspects of Shuttle testing, NASA believed it could modify a facility left over from previous programs to handle the SRB testing. In this instance, the Agency chose Bldg. 4572, a facility originally built for the Redstone rocket nearly twenty years before and since used for succeeding generations of rockets. For the Shuttle's SRB, it was necessary to modify the structure to apply static and dynamic loads with the SRB lying horizontally.

NASA requested that Huntsville Division conduct both the design and construction of the modification to Bldg. 4572. The engineering design contract, performed by Connell & Associates for $86,500, was awarded on 9 October 1974 and completed on 15 May 1975. A contract for construction of the necessary revisions in the amount of $1,097,552 was awarded on 18 July 1975 to Harold Construction Corporation of Huntsville, with completion schedule for 1 April 1977.[21]

"SPACE SHUTTLE MATED GROUND VIBRATION TEST FACILITY" (Building 4450 Marshal Test Center) converted for Space Shuttle Testing.

The third MFSC structural testing facility updated by joint NASA-Corps effort was Bldg. 4550, a former Saturn V dynamic test bed that the Agency wished to convert into a Space Shuttle Mated Ground Vibration Test Facility. The somewhat awkward name was a good clue to the building's function. In it NASA intended to subject an actual Orbiter Vehicle assembled with all components to dynamic stresses reproducing those that would be found in flight, including strong vibrations. Even though Bldg. 4550 was the tallest building at the Center, and one of the tallest in northern Alabama, the conversion required broad structural modifications to enlarge the existing test bay from fifty feet by fifty feet to seventy-four feet by seventy-four feet of all clear space (the Orbiter's

wingspan is about seventy-nine feet). The 175-ton derrick on the test stand also had to be relocated as part of the bay area expansion, along with changes to the electrical, mechanical, and instrumentation systems. For this project NASA preferred to retain control of design engineering functions, but the Agency requested that the Corps of Engineers conduct the conversion construction. To this end, Huntsville Division invited bids during July 1975 and on 15 September awarded construction contract DACA87-76-C-9002 to Universal Construction Company, Decatur, Alabama. Worth $1,923,400 in original award value, the project was due for completion in February 1977.[22]

The Universal Construction contract for the Space Shuttle Mated Ground Vibration Test Facility was the last piece of Shuttle-related activity performed by the Huntsville Division in conjunction with NASA at the MSFC. During the course of Shuttle construction, however, NASA had developed a working relationship with the Division strengthened by three projects that were not associated with the Shuttle. Though relatively small in dollar value, each of these miscellaneous NASA projects had several points worthy of mention in this **History.**

The first MSFC non-Shuttle project was also the smallest. Following the award of contracts for the Acoustic Model Engine Test Facility and the Electrical Laboratory Addition in February 1973, NASA asked for and received Corps assistance in revising the climatic control system for Bldg. 4487. System design was retained by NASA, but Huntsville Division awarded the $183,287 construction contract to Quinn Construction Company of Huntsville on 29 May 1974. The major part of this job consisted of removal and replacement of the system's sixty-ton chiller unit and associated service lines.[23]

Huntsville Division's second non-Shuttle task at the MSFC was born out of a violent act of Mother Nature. In early April 1974 a tornado struck Bldg. 4200, a modern glass-and enamel panel ten-story office structure housing the headquarters of the MSFC. In the flick of an eye, the storm twisted the building a few centimeters and released it, passing on to inflict severe damage and several deaths in the Huntsville area. In the aftermath of the storm, inspection revealed dozens of broken windows, warped window frames, twisted mullions and gutters, and several four-foot by four-foot procelain enamel inserts stripped from the building's exterior curtain wall. What lay beyond this in the internal steel framing no one knew for sure, since a precise assessment would have necessitated either pulling off most of the damaged external curtain wall or removing many hundred feet of complicated heating ducts along the interior floor baseboards. Neither was a very palatable or practical alternative. In the ensuing weeks, NASA architects evaluated the damage as best they could, and the Agency advertised for repairs. Bidding response was poor, however, probably because potential contractors were put off by a somewhat ambiguous work description and fears that a contract might bind them to repair as yet undiscovered damages beyond the curtain wall exterior. The one bid of $550,000 received was judged unacceptably high, and constrained by fiscal year budgetary allocations, NASA solicited Huntsville Division for advice.

Division engineers examined the building, assessed the curtain wall damage, and determined that internal structural framing damage was probably minimal. The Division then organized a unit price schedule through which a contractor could bid on twenty-four specific categories of repair items and operations--replacing a window frame, for example, or repairing a mullion. To further reassure potential bidders, an all-day prebid conference complete with a walk-through damage inspection tour led by Huntsville Division's William Major was held at Bldg. 4200. These procedures produced five bids, among which was a low bid of $274,728.30 offered by K & M Paint & Glass of Huntsville. K & M's low bid was accepted by NASA, and a Corps contract was awarded on 10 October 1974. Even though the original contract value was raised some $10,000 by two subsequent modifications, the Division achieved a savings of some $265,000 for the Space Agency.[24]

The third non-Shuttle project carried out by Huntsville Division for NASA reflected the Agency's diversification beyond space exploration and the increasing national interest in new energy sources beyond petroleum. To encourage investigation of alternative energy sources, in 1974 the Congress passed the "Solar Heating and Cooling Demonstration Act." It was signed into law by President Ford on 3 September 1974. The Act called for a $60 million, five-year program for technology research and development on solar heating and cooling for buildings. The research, development, and demonstration were to be handled by NASA, since the Space Agency had considerable experience with the unique scientific knowledge and specialized technology to exploit the sun's radiation. In constructing their "Solar Heating and Cooling Breadboard Test Facility," however, NASA believed that the Huntsville Division could offer assistance in design and construction of the facility of the tight time

schedule that the Agency faced.

NASA's design criteria were specified in November 1975, and because of the pressing need date, the engineering design was performed in-house by the staff of the Engineering Division rather than contracted through an AE firm. The resulting design provided the capability to test either air or liquid (water, water-ethylene glycol) solar heating and cooling systems and subsystems with total solar collection, or with total or partial simulation of solar collection. Two active solar panel areas could collect and supply solar energy; one passive panel without fluid connections served to evaluate the effects of thermal stagnation and the effects of the weather. All three structures were simple wooden truss frameworks supporting solar collection panels. Test bed facilities nearby housing complexes of pumps, heat exchangers, fans, cooling coils, a cooling tower, electric hot water boilers, and centrifugal chillers to permit concurrent testing of solar energy equipment. Instrumentation was to be provided by NASA. Structurally, the "thermal breadboards" required remodelling one existing utility building and the relocation of two others on new slabs.

A contract for the above construction was awarded to Ivey's Plumbing and Electrical Company, Inc., of Kosciusko, Mississippi, on 17 March 1976. Ivey's low bid of $647,243 compared favorably with Government estimates of $644,068. Originally due for completion on 1 November 1976, ten sizeable modifications worth $66,190.27 delayed acceptance of the project until 22 April 1977.[25]

"Solar Heating and Cooling Breadboard Test Facility" designed in-house by Huntsvillians and constructed under contract at Marshall Test Facility.

CHAPTER V FOOTNOTES

I. The Bulk Mail Centers Procurement for the U.S. Postal Service

[1]Typescript report by Dennis S. Lavery, PhD, for the Corps of Engineers, "The Postal Support Effort in the Corps of Engineers," 17 February 1976, pp. ii -3. Henceforth cited as Lavery, "Postal Report for CE."

[2]This is the opinion presented in Lavery, "Postal Report for CE," pp. 4-5, and that of personnel involved in the Postal mission at USAEDH.

[3]Lavery, "Postal Report for CE," pp. 4-5.

[4]Ibid.,pp. 5-9.

[5]Memo of Howard H. Callaway, Sec. of Army, for Sec of Def, 6 Jun 74, concerning assumption of ERDA coal gasification work by Corps of Engineers. USAEDH ERDA Liaison Office file, Memoranda of Agreements.

[6]"Memorandum of Working Agreement Between the Post Office Department and the Corps of Engineers, Department of the Army Providing for the Assignment of USPOD Facilities Program Functions to the Corps of Engineers," signed by Maj. Gen. D.A. Raymond, Director of Military Construction, OCE, and by L.P. Gyh, Assistant Postmaster General, Post Office Department, on 20 May 1971,USAEDH Procurement and Supply Division file, Postal Procurement.

[7]"Memorandum of Agreement Between the Post Office Department and the Department of the Army Providing for Postal Facilities Acquisition Services," signed by Stanley R. Resor, Sec of the Army, and Winton M. Blount, Postmaster General, on 11 March 1971; Lavery, "Postal Report for CE," pp. 9-11.

[8]Lavery, "Postal Report for CE," passim.

[9]Ibid., pp. 65-66.

[10]Ibid., p. 66.

[11]Ibid., pp. 66-67; personal interviews with Roy E. Edwards, Chief, Postal Field Support Branch, USAEDH-PS, March 1977 and April 1978.

[12]Lavery, "Postal Report to CE," p. 67.

[13]Ltr, OCE to Division Engineer USAEDH, 26 Nov 71, sub: Procurement of Fixed Mechanization Components for the Postal Service Bulk Mail System. USAEDH Procurement and Supply Division file, Postal Support Mission.

[14]Ibid.

[15]Personal interviews with Roy E. Edwards, Chief, Postal Field Support Branch, USAEDH-PS, March 1977 and April 1978.

[16]Ltr, OCE to Div Engr USAEDH, 26 Nov 71, sub: Procurement of Fixed Mechanization Components for Postal Service Bulk Mail System. USAEDH-PS, Postal Support Mission File.

[17]USAEDH-PAO, "Information Bulletin," IV, No. 17 (15 Oct. 1971), p. 3.

[18]"Memorandum of Agreement Between the SAFEGUARD System Organization and the U.S. Army Corps of Engineers Providing for Use of the Huntsville Engineer Division in the Procurement of Fixed Mechanization Equipment for the Postal Service Bulk Mail System," signed by Lt. Gen. F.J. Clarke, Chf of Engrs, and Lt Gen W.P. Leber, SAFEGUARD System Manager, on 22 Nov 71. USADEH-PS, Postal Support Mission File. This document is also reproduced in USAEDH-PAO, "Historical Summary FY 1972," II, Documents, p. 74.

[19]Ibid.

[20]See, for example, ER 10-1-22 editions of 28 July 1972 and 20 January 1975.

[21]USADEH-PAO, "Historical Summary FY 1972," II, Documents, p. 73.

[22]Lavery, "Postal Report for CE," p. 68; USAEDH—PAO, "Information Bulletin," V, No. 9 (22 Sept. 1972), p. 1.

[23]Personal interviews with Roy E. Edwards, Chief, Postal Field Support Branch, USAEDH-PS, March 1977 and April 1978, and with Thor S. Anderson, Chief, Procurement and Supply Division, USAEDH, May 1978.

[24]Personal interviews with Roy E. Edwards, Chief, Postal Field Support Branch, UASEDH-PS, April 1978. The text of ER 1180-6-1, "Government Furnished Property for Postal Bulk Mail Centers," 4 June 1973, is entirely reproduced in USAEDH-PAO, "Government Furnished Property (GFP) After Action Report: Bulk Mail Postal Procurement Program, USPS Modernization Improvement Program," April 1977.

[25]USAEDH-PAO, "Government Furnished Property (GFP) After Action Report: Bulk Mail Postal Procurement Program, USPS Modernization Improvement Program," April 1977, p. 7. Henceforth cited as USAEDH-PAO, "Postal GFP After Action Report."

[26]USAEDH-PAO, "Information Bulletin," V, No. 9 (22 Sept. 1972), p.1.

[27]Personal interviews with Roy E. Edwards, Chief, Postal Field Support Branch, USAEDH-PS, March 1977 and April 1978; USAEDH-PAO, "Postal GFP After Action Report," passim; Lavery, "Postal Report for CE," pp. 70-71.

[28]Personal interviews with Roy E. Edwards, Chief, Postal Field Support Branch, USAEDH-PS, March 1977 and April 1978; USAEDH-PAO, "Postal GFP After Action Report," pp. 6-7.

[29]USAEDH-PAO, "Postal GFP After Action Report," pp. 8-11; Lavery, "Postal Report for CE," pp. 76-77.

[30]The concept of "subscription mailing" was extensively discussed through several interviews with Roy E. Edwards during the spring of 1978. His comments were supplemented by careful review and further information supplied by James Reynolds, Contract Specialist of the Procurement and Supply Division. The descriptions in Lavery, "Postal Report for CE," pp. 73-75 are highly generalized and somewhat misleading.

[31]Personal interview with Roy E. Edwards, April 1978.

[32]The figure of $441,816.00 is supplied by Lavery, "Postal Report for CE," p. 75.

[33]Personal interview with Roy E. Edwards, April 1978.

[34]Personal interview with Roy E. Edwards, April 1978; Lavery, "Postal Report for CE," pp. 74-75.

[35]Personal interview with Roy E. Edwards, April 1978.

[36]USAEDH-PS raw input data for "Historical Summary FY 1976," USAEDH—PAO Historical Summary file.

[37]Memo to the author from Thor S. Anderson, July 1978.

[38]Report, U.S. General Accounting Office (Atlanta Regional Office), February 1974, "Summary on Survey of the Mechanization Acquisition for the National Bulk Mail System (Code 22269)," pp. 16-17.

II. The NASA Space Shuttle Mission and Other NASA Projects

[1]NASA, "National Aeronautics and Space Administration. Space Shuttle Fact Sheet," October 1972, pp. 2-3.

[2]Ibid., p. 4.

[3]Ibid., p. 5.

[4]Formerly called the Mississippi Test Facility (MTF).

[5]"Memorandum of Agreement Between the SAFEGUARD System Organization and the US Army Corps of Engineers Providing for USE of the Huntsville Division for other than SAFEGUARD Projects," signed by Lt. Gen. F.J. Clarke, Chief of Engineers, and Lt. Gen. W.P. Leber, SAFEGUARD System Manager, on 8 Jun 72. NASA Memorandum of Agreement file, USAEDH-ED. This "Memorandum of Agreement" is not reproduced in the "Historical Summary FY 1972."

[6]USAEDH-PAO, "Historical Summary FY 1972," I, Narrative, pp. 1-5; USAEDH-PAO, "Historical Summary FY 1973," I, Narrative, pp. 1-8.

[7]See Division organization charts in the "Historical Summary" for FY 1972 and 1973.

[8]Personal interviews with William Major, Project Management Branch, USAEDH-ED, March 1977 and May 1978; Miscellaneous "Project Descriptions." USAEDH-ED, NASA Project Descriptions File.

[9]Miscellaneous "Project Descriptions," USAEDH-ED, NASA Project Descriptions File.

[10]Contract Record File, AE Contract Records Section, USAEDH-ED.

[11]Miscellaneous "Project Descriptions," USAEDH -ED, NASA Project Descriptions File.

[12]Miscellaneous "Project Descriptions," USAEDH-ED, NASA Project Descriptions File.

[13]Miscellaneous "Project Descriptions," USAEDH-ED, NASA Project Descriptions File; NASA, "NASA Shuttle Construction Projects Data Book," 30 April 1976, pp. 51-52.

[14]NASA, "NASA Shuttle Construction Projects Data Book," 30 April 1976, pp. 51-52; Miscellaneous "Project Descriptions," USAEDH -ED, NASA Project Descriptions File; Personal interviews with William Major, Project Management Branch, USAEDH-ED, March 1977 and May 1978.

[15]NASA, "NASA Shuttle Construction Projects Data Book," 30 April 1976, pp. 51-52; Miscellaneous "Project Descriptions," USAEDH-ED, NASA Project Descriptions File; Personal interviews with William Major, Project Management Branch, USAEDH-ED, March 1977 and May 1978.

[16]Frank D. Lewis and George G. Stewart, "The Corps and the Space Shuttle Program," **The Engineer,** VI, No. 3 (July-Aug.-Sept. 1976), pp. 28-31; Craig Covault, "Shuttle Engine Delays Overcome," **Aviation Week and Space Technology,** CV, No. 1 (5 July 1976), pp. 43-49.

[17]NASA, "NASA Shuttle Construction Projects Data Book," 30 April 1976, pp. 3, 25; USAEDH-PAO, "Historical Summary FY 1973," II, Documents, p. 109; NASA program scheduling data sheets dated 11 Apr 75 retained by William Major, Project Management Branch, USAEDH-ED.

[18]USAEDH-PAO, "Historical Summary FY 1973," II, Documents, p. 98; NASA program scheduling data sheets dated 11 Apr 75 retained by William Major, Project Management Branch, USAEDH-ED.

[19]USAEDH-PAO, "Historical Summary FY 1973," II, Documents, p. 100; Miscellaneous NASA program scheduling data sheets retained by William Major, Project Management Branch, USAEDH-ED; Personal interviews with William Major, Project Management Branch, USAEDH-ED, March 1977 and May 1978.

[20]NASA, "NASA Shuttle Construction Projects Data Book," 30 April 1976, pp. 11-13; Miscellaneous NASA program scheduling data sheets dated 11 Apr 75 retained by William Major, Project Management Branch, USAEDH-ED; USAEDH-PAO, "Historical Summary FY 1975," II, Documents, p. 99.

[21]USAEDH-PAO, "Historical Summary FY 1975," II, Documents, p. 102; USAEDH-PS raw input data for "Historical Summary FY 1976," USAEDH-PAO "Historical Summary FY 1976" raw input data file.

[22]NASA, "NASA Shuttle Construction Projects Data Book," 30 April 1976, pp. 15-16; USAEDH-PS raw input data for "Historical Summary FY 1976," USAEDH-PAO "Historical Summary FY 1976" file.

[23]USAEDH-PAO "Historical Summary FY 1974," II, Documents, p. 122.

[24]Personal interviews with William Major, Project Management Branch, USAEDH-ED, March 1977 and May 1978; USAEDH-PAO, "Historical Summary FY 1975," II, Documents, p. 97.

[25]Personal interview with Clyde C. Wright, Mechanical-Electrical Branch, USAEDH -ED, May 1978; USAEDH-PS raw input data for "Historical Summary FY 1976," USAEDH-PAO "Historical Summary FY 1976" file.

CHAPTER VI

THE MUNITIONS PRODUCTION BASE MODERNIZATION AND EXPANSION PROGRAM

On 20 November 1973 an official directive to Col. Lochlin W. Caffey, Huntsville Division Engineer, from Maj. Gen. D.A. Raymond, Deputy Chief of Engineers, OCE, formally assigned Huntsville Division a major new military construction mission. Effective immediately, the Division was officially designated as the Corps' central management agency for the huge Munitions Production Base Support Construction Program (MPBSCP). The MPBSCP, then three years old, was a high priority effort on the part of the Army Materiel Command (AMC) to modernize, expand, and maintain the Army's munitions manufacturing base for the last quarter of this century. Because of inflationary factors and political vagaries, nobody knew exactly what the ultimate cost would be, but 1973 estimates were in the vicinity of $3.5 billion. Because of the immense dollar value of the program, and because certain aspects of modernized technology had yet to be worked out, the MPBSCP was spread out over twelve years.

General Raymond's tasking letter marked the genesis of Huntsville Division's third activity after SAFEGUARD and its first new military engineering assignment since BMD. Like its predecessors, the new mission was technologically challenging, geographically extensive, and highly demanding of contractual and managerial expertise. Taken alone, these factors plus the heavy budgetary investment and lengthy programming of the MPBSCP would have made it a notable task for the Division. From the time of its assumption in 1973, however, the MPBSCP's importance for Huntsville Division was magnified even further by the concurrent phase-down in SAFEGUARD, by a general contraction in the BMD mission as a whole, and by well-defined limits on the duration and extent of the recent Postal and NASA missions then achieving maturity. Since 1973 the initial indications that the munitions program would become a large part of the Division's workload have been borne out. Annual appropriations for the MPBSCP have been somewhat reduced from original planning, but the overall length of the program has been stretched out to FY 1999. Hence, in the post-ABM Treaty era the MPBSCP was, and promises to remain for sometime, a most important mission for Huntsville Division.

The origins of the MPBSCP are easy to identify: the munitions program of the 1970's is rooted in the age of the United States' munitions production facilities and in the march of military and industrial technology since World War II. Most Army ammunition plants operating in the decade of the 1970's were built during a remarkable wave of construction during the first years of World War II that helped make America the "arsenal of democracy." But it was an arsenal built in great haste under wartime exigencies, and to create it, drastic corners had to be cut in the quality of construction materials and operator safety. As early as February 1941 it was decided to switch to a type of temporary construction for munitions plants having a **five-year** life expectancy; as Corps historians Fine and Remington have vividly written, those plants built during actual hostilities admitted even greater compromises:

> As has been shown, until Pearl Harbor the Army had built Ordnance and Chemical Warfare facilities largely of durable materials and had exercised great care to minimize the dangers of explosion. But once the country was at war, the need for conserving materials prompted consideration of drastic changes in design. Early in 1942 DuPont advised General Campbell that it could develop a plan for stripped down TNT plants. Although these plants would be more expensive to operate and maintain. DuPont was confident they would be more satisfactory in every other way. The West Virginia Ordnance Works, one of the first plants built on the new model, included such features as process buildings with asbestos siding; wooden shops, dormitories, and administration buildings; utilities with five-to-ten year life; concrete water tanks; barbed wire fencing; and duckboard sidewalks. West Virginia took 7 months to build as compared with 21 months for some of the earlier TNT plants. The DuPont typical became the wartime standard for explosives projects and started a trend which accelerated as shortages became more and more acute.[1]

It was munitions plants of this type that carried the nation to victory in 1945 and, in fact, sustained the next thirty years of Army ammunition demand.

The post-World War II years found the U.S. with a munitions base quite adequate for its peacetime forces, so new construction was minimal. The most decrepit and least efficient plants were disposed of, abandoned in place, or deactivated, while the remainder soldiered on through the Korean buildup. The uneasy peace of

the late 1950's and early 1960's saw little change in the nation's munitions facilities; expenditure was confined almost exclusively to routine maintenance.Worn-out motors, bearings, shafts, tanks, piping, and utilities were replaced item-for-item; roofs were repaired; fresh coats of paint were applied. The most crying deficiencies were corrected, but the equipment and processes of the 1960's were still 1940-vintage batch type, with human labor providing most of the materials handling. The intervention in Southeast Asia was undertaken with what were originally temporary World War II facilities still in operation--not a single new AAP had been built since 1945. The costs in dollars and human hazards were high.

Heavy munitions demands of the Vietnam War, along with two decades of technological progress and evolving attitudes towards the environment, helped expose the need for modernization of the country's munitions production base. Since World War II, the use of ammunition-gobbling automatic weapons and improved artillery increased ammunition demands enormously; so also did the proliferation of exotic munitions types such as cluster bomb units (CBU), special armor-piercing projectiles, delayed-action mines, and tube-launched missiles. The chemistry of blasting, too, had moved beyond the World War II era with the development of RDX and Composition B explosives as supplements to TNT. Equipment twenty-five years old made the production of either traditional or innovative types of munitions slow, inefficient, costly, and unreliable. In the case of nitroguanidine, a key ingredient in RDX and other new explosives, a lack of domestic facilities made the nation dependent upon Canadian exports. Amazingly, even in the late 1960's, TNT batches were still being mixed by hand with wooden paddles in wooden tubs, and shells and powder bags were being filled by manual means. Not suprisingly, accidents were often catastrophic because of the lack of blast suppressive shielding. Explosive plants, too, were notorious polluters of air and water; their emissions had formerly been casually dismissed as the inevitable by-products of the explosives business, but federal and state cleanup legislation of the 1960's mandated a change in this attitude. Again, the existing facilities were often not amenable to such change.[2]

Prodded by the high costs of reactivation for Vietnam and new pollution regulations, the Army acted to set its munitions house in order. In early 1968 a full scale modernization plan was presented to the Assistant Secretary of the Army for Installations and Logistics and the Office of the Secretary of Defense. Both agreed to support an aggressive modernization effort starting in FY 1970. It was initially estimated that it would cost $2.4 billion to modernize the plants and take five years. The program was later revised to seven years and then to ten years. Finally, in July 1970, the program was extended to twelve years through FY 1981 at a cost estimated at $4.2 billion. Of this total, $233 million was tabbed for expansion. The first improvements were sought in small calibre ammunition production (SCAMP), where an effort to replace batch-type operation with continuous automated line production of 5.56-mm rifle cartridges was started at the Frankfort Arsenal in 1968. A little later, in 1970, the Army commenced modernization of its propellant and explosives plants (P&E) with nine "turnkey" (combined design and construction contract) acid plant projects and two TNT projects. Initial contract awards on these were made on 30 June 1970.[3]

Within two years, however, the munitions modernization program was mired in various troubles. A General Accounting Office report of 31 May 1972 criticized the Army's management of the program, and some corrective measures ensued. A comprehensive 168 page Army Audit Agency report of 31 May 1973 entitled "Audit of the Army's Production Base Support Program," however, deemed the corrections inadequate and excoriated program management practices as a whole. In particular, the audit noted, the Army had instituted an omnibus design fund in February 1971, but on 30 November 1972, eighteen months after its start, only 20 percent of FY 1972 design funds had been spent. On 21 August 1972, the Commanding General, AMC, had established a Project Manager for the MPBME, but the Project Manager's Office did not begin to be staffed until December 1972 and no Project Manager had been appointed at the time the audit report was compiled. A Mechanized Milestone Reporting System that was supposed to be implemented by 1 July 1972 still was not operational on 15 January 1973. The audit was especially cognizant of embarrassing, costly tendencies to start-up projects before the requisite engineering and design were done or even before prototypes had proven successful. Early difficulties with 5.56-mm modularized SCAMP lines for the Twin Cities and Lake City AAP's were examples of this. There was also a deplorable tendency to hold onto funds and to request more funds, along with a singular reluctance to turn back unspent or unspendable monies. In Part II, "SUMMARY," the auditors wrote:

In our opinion, the Army needs to take a

hard look at its planned modernization and expansion program. Funding to date has exceeded the Army's ability to execute the program. But planned funding levels are even larger for future years of the 12-year program. Action is needed to match funding levels with execution capabilities before more problems generate. We can see two altenative courses of action the Army can take:

Either - Assign the management and engineering resources needed to provide the capability to execute the modernization and expansion program at planned funding levels.

Or - Limit the modernization and expansion program to funding levels that are commensurate with the Army's capability to execute the program.[4]

A little further along, the auditors specifically suggested that the Army should accelerate the engineering of munitions process technology and design; schedule follow-on projects only after successful testing of prototypes; implement a workable priority system for project selection and execution; set up a system to correlate the new manufacturing technology with the modernization program; and strengthen management procedures and controls to make sure that milestone dates for concept design, final design, and contract award would be met for all projects included in budget submissions for a given fiscal year.[5]

Almost immediately after issuance of the Army Audit Agency report, the Army took several steps to rectify managerial deficiencies in the munitions program. On 18 June 1973, Brig. Gen. Robert J. Malley was appointed Project Manager for the Munition Production Base Modernization and Expansion program (MPBME) which constituted by far the largest portion of the total MPBSCP. General Malley's Project Office was located at Picatinny Arsenal, Dover, New Jersey, with a small initial staff that grew during the remainder of the year towards a June 1974 target level of 160. As defined by the "Project Manager Charter" of 8 September 1973, "The Project Manager is the Army focal point for operational control of the MPBME program." The same document delineated the Project Manager's mission:

> He will exercise centralized management authority over the planning, direction, control, and execution of the MPBME program at all US Army Ammunition Plants and Arsenals and for government equipment located at contractor owned and operated facilities included in the MPBME program. The MPBME program assigned to the Project Manager includes modernization and expansion and Production Engineering Measures (PEM) directly associated with the MPBME.

Following his appointment, General Malley was to report directly to the Commanding General, U.S. Army Materiel Command (AMC), the "boss" of the entire MPBSCP. In late 1975, AMC became the U.S. Army Materiel Development and Readiness Command (DARCOM) but without significant change in function as supervisor of the MPBSCP as a whole.

The mainstream within General Malley's MPBME was, and is, modernization and expansion work at the twenty-five Government-owned, contractor-operated (GOCO) plants that comprise the present backbone of the Army's munitions production base. These GOCO plants generally manufacture high demand items ranging from 5.56-mm small arms rounds to 8-inch artillery shells. MPBME project areas at various GOCO plants include propellants and explosives (P&E), together with related acid plant facilities; small (5.56-mm through 30-mm) ammunition facilities; load assemble, and pack (LAP) facilities; metal parts facilites; and pilot plants. Additionally, the MPBME includes modernization and expansion of 125 Government-owned plant equipment packages (PEP) containing 345 production lines situated in private industry. The PEP's generally manufacture specialty items such as small metal parts, fuses, and rockets. Finally, the MPBME includes the Manufacturing Methods and Technology (MM&T) effort which develops the advanced process technology needed to back up modernization and expansion. The MPBME is funded with Procurement of Ammunition Army (PAA) funds (formerly PEMA) channeled through Armament Command (ARMCOM) financial controls to the Project Manager.

The MPBME was, and is, a large program, but it is not quite synonymous with the still wider MPBSCP. Related to the MPBME and integrated with it in the MPBSCP are two other programs for improvement of the munitions manufacturing base. Annual Support, or the Production Support and Equipment Replacement (PS&ER) program, supports annual maintenance that sometimes borders on modernization. The PS&ER is funded with PAA funds but is directed by ARMCOM, a command subordinate to AMC/DARCOM, from Rock Island, Illinois. A Pollution Abatement Program for control of emissions at munitions plants is funded with Military Construction, Army (MCA) monies and

executed under direction of the Chief of Engineers. In addition to these, there is a minor miscellany of MCA, MCA Minor, and Operation and Maintenance funded projects that are part of the MPBSCP. As will be seen shortly, the Corps of Engineers and Huntsville Division have had heavy design and construction responsibilities in all these MPBSCP areas.

Besides the appointment of General Malley as Project Manager for MPBME and the staffing of his Picatinny office, the Army took other measures to see that the MPBSCP was put back on track for FY 1974. During the remainder of calendar year 1973 steps were taken within the munitions community to improve coordination among AMC, ARMCOM, MPBME Project Manager, and Office of Secretary of Defense to insure that available appropriations for the MPBSCP were applied to the highest priority work. At the same time, overall funding for the MPBME was reduced from about $500 million per annum to about $300 million for FY 1974, and the program was stretched out even further to FY 1999.[7]

One of the most important managerial decisions made for the MPBSCP in 1973, however, was the introduction of Huntsville Division into the program as the central managerial agency for the Corps of Engineers which was engineering and constructing MPBSCP facilities. Since the inception of the MPBSCP in 1970, the Construction Division, Directorate of Military Construction, OCE had provided such central management. At this time (Before the establishment of the MPBME Project Manager's Office) individual munitions projects were directly allocated by ARMCOM to Corps geographic divisions and districts for design and construction. There was no central agency other than OCE interfacing with all Corps divisions and districts that could function on a day-in-day-out basis as a repository of technical information and milestone reporting. The single exception was Mobile District's management of acid plant design.

Immediately after his appointment as MPBME Project Manager, General Malley discussed the problems of facility design and construction with Generals Clarke, Gribble, and Wray at OCE. General Clarke suggested that General Malley should consider Huntsville Division for design of the facilities; General Gribble agreed but indicated that construction should be accomplished by the appropriate districts. This formula was to become the basis of Huntsville Division's participation in the MPBSCP. On 22 June 1973 General Malley telephoned Brig. Gen. Bates. C. Burnell to broach the idea of Division support in accomplishing the design for munitions plant modernization and expansion. General Burnell concurred, indicating "that the type of support desired by General Malley should fit very closely with the capabilities of Huntsville Division."[8] At the conclusion of this conversation, General Burnell summoned Deputy Division Engineer Col. Peter Grosz, Jr., and Lee Garrett, Chief of the Engineering Division, and briefed them to begin planning for the MPBME support mission. One of their first objectives was a working plan for the Division's role in the munitions program; a second was securing the concurrence of General Gribble, the Chief of Engineers.[9]

By early September a preliminary draft of ideas for Huntsville's participation in the MPBSCP had been generated by the Division's staff, and on 10 September 1973 Maj. Gen. George A. Rebh, Acting Deputy Chief of Engineers, telephoned the tentative approval of OCE.[10] An official follow-on message from OCE on 14 September notified divisions and districts of an impending change in the management of Corps activities in support of PEMA construction. By 25 September a final ten page "Plan for Corps of Engineers Support to Army Materiel Command for Ammunition Production Base Construction Program" with several bulky appendices had been prepared in conjunction with OCE. This plan outlined essential provisions whereby Huntsville Division would become the central operating agent of the Corps in managing MPBSCP design and construction. The plan embodied the principle of central program control and provided for continuity of engineering from advanced planning through concept design, final design, and construction with configuration management at each stage as appropriate.[11]

Two letters from OCE, one dated 16 October 1973, the other 20 November 1973, completed the official assignment of the MPBSCP support mission. The letter of 16 October presented the basic mission assignment and asserted that further details would be provided by 19 November. In the meanwhile, a number of ground-breaking conferences with other elements of the MPBSCP infrastructure--Corps geographic divisions and districts, ARMCOM, and the Project Manager--were scheduled to actually get the mission underway. Now gathering headway, the MPBSCP was proudly heralded in the 15 October issue of the Division's "Information Bulletin."[12]

The OCE letter of 20 November may be considered the definitive mission assignment, since appended to it was a detailed eleven page implementation directive entitled "Instructions for Corps of Engineers Support to Army Materiel Command Munition Production

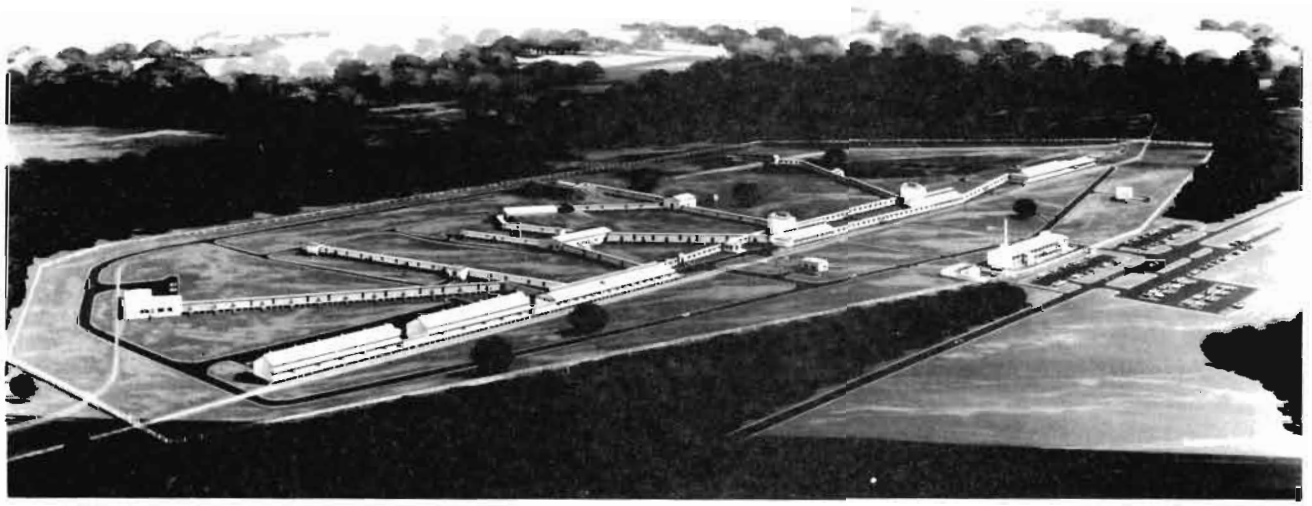
Base Support Construction Program."[13] This key OCE document incorporated the Division plan of September almost verbatim, with the exception of some funding data unavailable earlier. The "Instructions" defined the working relationships among Corps of Engineers and AMC organizations, designated the general functional and task assignments, presented organizational structures, and outlined pivotal plans. Curiously enough, a formal "Memorandum of Understanding Between the Project Manager for Munitions Production Base Modernization and Expansion (MPBME) and the Corps of Engineers for Support of the MPBME Construction Program" was not signed until 15 January 1975, or about eighteen months after General Malley first broached the idea of using Huntsville Division to OCE. The first Huntsville Division ER 10-1-22 edition to acknowledge the MPBSCP mission was that of 20 January 1975. Both of these documents were further clarified in an "Operations Manual for Munitions Production Base Support Construction Program (MPBSCP)" issued by OCE on 13 September 1976.[14]

As prescribed by the 20 November tasking letter, the Huntsville Division was " responsible to the Chief of Engineers for techincal and fiscal management of all MPBSCP activities." Individual projects would be assigned on a case-by-case basis to districts through their parent divisions; districts would return reports, schedules, estimates, designs, and other data as required to Huntsville Division. Huntsville liaison with the Project Manager would be maintained through a Division-staffed Liaison Office collocated with the Project Manager at Picatinny Arsenal. Similar project management and control would be provided to ARMCOM, but because of the smaller volume of work, only a liaison representative would be sent to Rock Island. The practices for handling of design duties in the MPBSCP were commensurate with the complexity of this mission. Huntsville Division was responsible for overall management of the design effort for the MPBSCP. Generally, Huntsville was to accomplish design of all process systems common to two or more sites--this to keep duplication of effort and "re-invention of the wheel" to a minimum--while districts were tasked for the balance. Hunstville Division was to design all new sites. As a general rule, geographical districts were responsible for design of site peculiar facilities and site peculiar pollution abatement projects; site adaption of multisite designs; and designs of MCA, MCA Minor, and Annual Support projects. Construction in all cases was to be accomplished by the district having responsibility for military construction in the region in which the project was located.[15]

Reorganization of the Division's internal structure for the MPBSCP proceeded at a rather leisurely pace during 1974. The MPBSCP Project Liaison Office at Picatinny was in being by February 1974 with Harvey C. Aden as Chief and Maj. H.C. Watson as Project Engineer, while on 18 August 1974, A.J. Manassero was assigned to ARMCOM Headquarters at Rock Island, Illinois, as liaison officer. Within the Division proper, MPBSCP assignments experienced a rather checkered career from 1973 on as the Project Management Branch of Engineering Division shifted its orientation from BMD to a munitions focus. A hand-drawn map in Division files dating from about October 1973 shows that the first apportionment of munitions tasks in the Project Management Branch was on the basis of five geographic zones with a general Project Manager for the handful of AAPs in each region. This geographic arrangement, though, was not formalized for another eight to ten months while the office of Chief, Project Management Branch, remained vacant. By February 1975, Robert K. Sawyer had been made Chief of the Branch and the Branch reorganized with a Project Managers Section. Four project managers within the Section now handled AAPs in southeastern, southwestern, northeastern, and north-central regions, while a fifth project manager was responsible for the remaining BMD work. In a subsequent 1976 reshuffling, MPBME munitions tasks were delegated on a topical basis to a staff of nine under four project managers: James G. Winter, Propellants and Explosives; James T. Ammons, Load, Assemble, and Pack; Reginald L. McLeod, Metal Parts; and George Barter, Acid Plants. PS&ER projects supplemental to MPBME were divided among project managers according to the AAP where they were located. Assistance relating to technical specialities such as specifications, estimation, and electrical and mechanical items was furnished by other Engineering Division branches and sections.[16]

The staff of the Construction Division has also had a limited role in surveillance of MPBSCP construction and in the reprocurement of several FY 1971 and 1972 "turnkey" acid plant projects contracted to Chemical Construction Co. (Chemico) before Huntsville Division entered the munitions program. In November 1975, with construction work about 90 percent complete, the Army suspended its payments on these contracts because of funding shortages unrelated to contractor performance; Chemico then sued, claiming the Government breached their

Central X-Ray Facility, Milam, Tennessee



Melt-Pour Modernization Line "C" Milan Ammunition Plant, Miliam, Tennessee

contract, and withdrew from its acid plant construction work at Badger, Radford, and Sunflower AAPs. The Government countered by terminating for default. After the Army lifted the suspension of payments some time later, Ned Rizzardi of the Huntsville Division, along with staff from Omaha and Norfolk Districts, surveyed the remaining scope of work at the three AAPs| on behalf of ARMCOM. At Sunflower and Radford AAPs, the plant contractor-operator was eventually engaged to complete the job; at Badger AAP, the work remaining was awarded to an industrial contractor for completion. These three "wrap-up" jobs and a fourth similar one for a chemical waste treatment plant at Joliet AAP are now under the management of Huntsville's Construction Division staff.

After assignment of the MPBSCP mission to Huntsville Division and early in the program, the MPBSCP Project Office at Picatinny Arsenal suggested that Huntsville develop a GFP procurement plan for the acquisition of long-lead items for AAP construction. A GFP plan, it was thought, might reduce construction time and effect maximum economies of acquisition.The concept, however, never got beyond approved procurement plan status, so there exists no valid method of evaluating the benefits, if any, to be derived from Government acquisition of industrial plant equipment for AAPs.[17]

THE FIRST 3 of 6 Continuous Pour TNT Lines constructed at Volunteer AAP near Chattanooga, Tennessee.

A comprehensive description of all of the munitions projects under the Division's supervision is made both redundant and impracticable by the sheer number and variety of jobs. At any given time during 1974-1976, the Division staff was supervising several dozen projects of quite disparate nature and value scattered among twenty-five arsenals and AAPs across the United States. Furthermore, some of the Division's munitions projects have exhibited the "now-you-see-it, now-you-don't" properties of the magician's rabbit as shifting defense priorities and funding fluctuations slip projects from one fiscal year to another or suspend them altogether. Congressional actions, too, have had an impact on scheduling, particularly affecting the siting of projects with optional locations. For these reasons, this **History** will focus on several of the more important, interesting, or on-going MPBSCP projects illustrative of the Division's overall role in this area.

A high degree of historical significance in the MPBSCP must be given to the Division's work on the Army's first new AAP since World War II. A directive to commence criteria development for a new AAP dedicated to the manufacture of the ICM M483 155--

mm artillery round was sent to Huntsville Division in August 1974. Construction was to be funded in FY 1977. The site chosen was the federal reservation in southern Mississippi where the NSTL was located. The product of the new facility was to be a new projectile for 155-mm howitzers, the "Improved Conventional Munitions," or ICM, round made up of hollow artillery shell forty-two inches long acting as a carrying container for a "cargo" of eighty-eight M42 and M46 grenades. The round is fuzed to scatter the grenades at a predetermined height over an area about the size of a football field which would be saturated with mixed explosions of anti-personnel bomblets and anti-armor shaped charges.

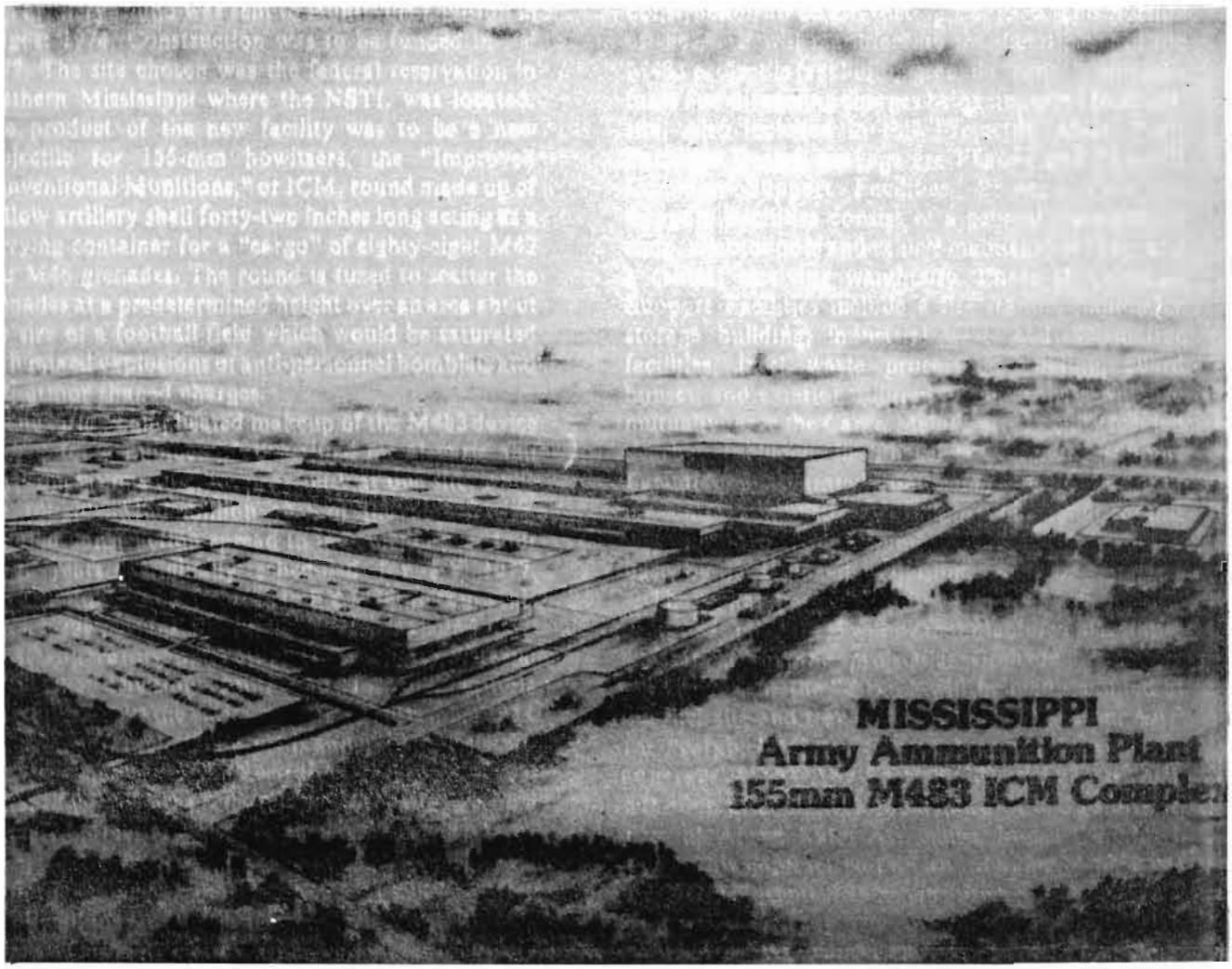
The rather complicated makeup of the M483 device argued for a number of diversified metal parts and LAP operations in close proximity at one site, while the roughly $180 million cost of the new facility dictated construction spread in increments over four fiscal years. Originally scheduled for FY 1977, construction is now to begin in FY 1978. Because this was a large new installation without an existing AAP plant operator-contractor to suggest criteria, Huntsville Division contracted for AE criteria development for the entire site. On 12 November 1974, a contract for preliminary plans and design studies for the Mississippi AAP was awarded to Kaiser Engineers for $91,000; this was followed on 2 April 1975 with a second contract to Kaiser Engineers (DACA87-75-C-0038) in the amount of $983,550 for criteria development. By the beginning of 1977, two modifications to the Kaiser criteria contract had boosted cumulative costs for criteria development to $1,777,846.

Once underway, however, the Mississippi AAP encountered a hiatus which has brought considerable delay and uncertainty in scheduling. Final site selection for the facility was deferred in 1975 by House of Representatives Appropriations Committee action which prohibited establishment of new AAPs while existing ones were being phased-down or mothballed. At the end of 1976 this restriction remained unaltered, rendering the ultimate location of the new facility indeterminate. Here, however, it will be referred to under its maiden name of Mississippi AAP.

Despite the setback of Congressional action, concept design commenced on the M483 Projectile Metal Parts Facilities portion of the AAP on 2 March 1976 under a United Engineers & Constructors, Inc., AE contract initially worth $772,507 (DACA87-76-C-0019). The current working estimates (30 September 1976) for construction costs were $65,600,000, with construction to be awarded in FY 1978. This portion of the AAP will manufacture the metal parts of the M483 projectile (excluding grenade "cargo") only, the fuzes and dispersing charges being imported from off-site. Also included in this Projectile Metal Parts Facilities Design package are Phase I and Phase II Common Support Facilities. Phase I Common Support Facilities consist of a general maintenance shop, a motor pool and vehicle maintenance shop, and a central receiving warehouse. Phase II Common Support Facilities include a fire station, flammable storage building, industrial waste and reclamation facilities, inert waste processing building, guard houses, and exterior utilities. Some of these will also mutually serve the Cargo Metal Parts Facility located nearby. Included in Phase I Common Support Facilities but separated from them for design purposes is a central administration building. The design for this was started in mid-November 1976 on an in-house basis by the Huntsville Division.

The metal parts of the M42 and M46 grenade "cargo" for the M483 will be manufactured in facilities separate from the projectile. Grenade fuzes and explosives for the "cargo" will be manufactured at another site and transported to the Mississippi AAP for "cargo" LAP operations. A general site design contract (DACA87-76-C-0020) requiring site adaption after site selection was awarded to the AE firm of Albert Kahn Associates, Inc., on 8 March 1976. This contract had an award value of $262,964 and by 29 November 1976 had grown to $576,239 after four modifications. The current working estimate of construction costs at the end of 1976 was $27 million.

Other major portions of the Mississippi AAP for which design had not been started in 1976 include the M483 LAP Facility with a programmed cost of $38 million; the Common Support Facilities, Phase III, programmed for FY 1982 at a cost of $1,975,000; the Sewage Treatment Plant, programmed for FY 1980 at a cost of $429,000; and a Power Plant for M483 Facilities, programmed for FY 1979 at a cost of $24,942,000. A DARCOM contract for plant operation of the facility was awarded in August 1976 to Mason Chamberlain, Inc., a joint venture of Mason Hanger-Silas Mason and Chamberlain Manufacturing Corporation. Final site selection for this project, however, was not expected before October 1977, and in the interim, Huntsville Division was proceeding on the Projectile Metal Parts and Cargo Metal Parts Facilities based on a hypothetical site with an option for later site adaption.[18]



Mississippi Army Ammunition Plant, Bay St. Louis, Mississippi

In August 1974, OCE formally directed Huntsville Division to assist the MPBME Project Manager in the development of criteria for a large new RDX/HMX explosives complex to be added to an undetermined AAP. The RDX/HMX project has since become a close rival to the Mississippi AAP in historical significance to the Division. This project was the first in the MPBSCP in which Huntsville Division developed both equipment design and facility design criteria. In the majority of other MPBME projects, criteria for modernization or expansion originate with the AAP plant operator-contractor concerned. In the case of the RDX/HMX project, however, the technology of the process was still in a formative stage, and the site for the new complex was undecided. Hence, the MPBME Project Office preferred to have Huntsville work up the design criteria through a specialist AE firm. An additional $75 million worth of process equipment will be designed and procured in parallel under direction of AMC/DARCOM for downstream delivery as GFE to the Corps of Engineers' construction contractors. In magnitude of costs, the RDX/HMX facilities' estimated $250 million construction cost (excluding AMC/DARCOM-procured process equipment) exceeds any other Huntsville Division munitions project. Design costs alone will amount to about $30 million.[19]

The RDX/HMX project entails design and constuction of two RDX/HMX production lines, together with their supporting chemical feedstock plants, recovery plants, a steam plant, utilities, support facilities, and waste treatment facilities. The production lines will be a new continuous and automated batch-type process patterned after an experimental line now operating at the Holston AAP at Kingsport, Tennessee. The Holston AAP, a GOCO plant operated by Holston Defense Corporation, a subsidiary of Eastman Kodak Corporation, has been developing basic RDX process technology on this

prototype line since 1969. This effort is part of the MM&T suport to modernization and expansion.

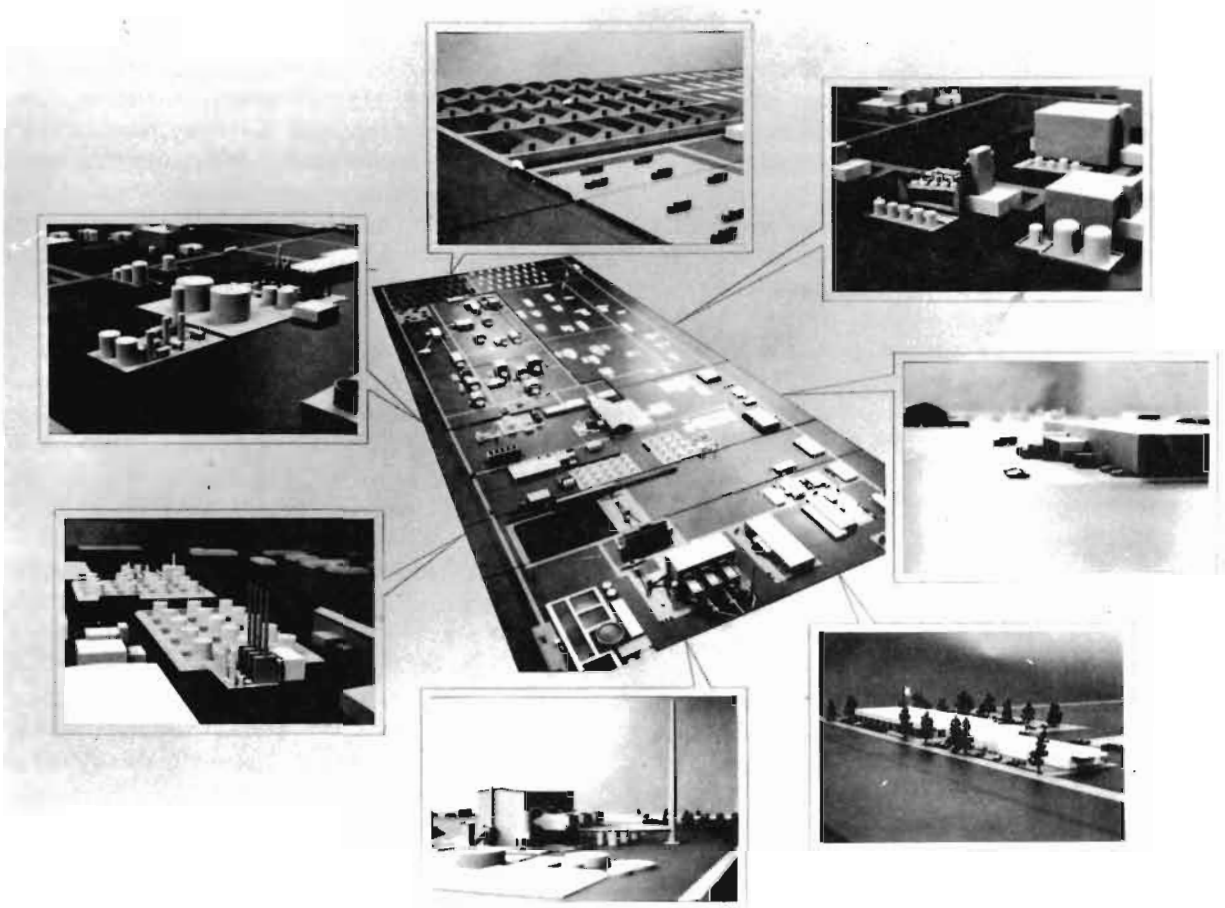
Nine other Holston conventional batch lines are currently the only source of RDX production for U.S. armed forces, even though the material is a base ingredient for the widely used Composition B and other modern explosive compounds. Composition B, a filler for artillery shells, mines, and grenades, is a compound of RDX plus TNT. The Holston facility was originally designed to make 40 million pounds of Composition B per month, but it is now required to make a host of other products also based on RDX and HMX. As a result, in 1973 Holston was scheduled at mobilization to make only 29 million pounds of Composition B, about one-third of projected need. To alleviate possible shortages, a new RDX/Composition B line is being planned for Holston AAP, and the RDX/HMX expansion project is being prepared for another AAP location. Prime candidates for location of the RDX/HMX expansion are Newport AAP, Newport, Indiana, which already has TNT production on-site, with Milan AAP and the McAlester Naval Ammunition Depot, which have no TNT facilities, also in contention.

The new facility will have two production lines with potential for expansion to four lines. Lines 1 and 2 differ slightly. Line 1 will produce 4.5 million pounds of RDX base per month which, when combined with TNT from other sources, will result in 7.5 million pounds of Composition B output per month. Line 1 will make RDX and Composition B only. Its major elements include buildings and equipment for nitrolysis, filtering, washing, recrystallization, dewatering, drying, and packaging.

Line 2 will feature variable production choices to make 4.5 million pounds per month of RDX as a base for either 7.5 million pounds per month of Composition B like Line 1, or lesser amounts of specialty products such as Composition C-4 and Composition PBX N-6. As an alternative to RDX, Line 2 will also be able to produce 0.5 million pounds per month of HMX base, an ingredient for the Octol explosive warheads of certain missiles. Except for additional facilities required for handling the product mix, facilities will be similar to Line 1. The control of product mix is to be computerized, and the operation of both lines will be fully automatic. All facilities producing explosives will be hardened for 7.5 p.s.i. of overpressure, and the complex must be capable of starting up from layaway in ninety days or less.

The chemical feedstocks for RDX production are acetic anhydribe, hexamine, glacial acetic acid, nitric acid, and nitric acid/ammonium nitrate. These ingredients will be prepared on-site and will require extensive preparation and recovery facilities of their own. The RDX/HMX project, therefore, also provides feedstock facilities producing 340 tons of 99 percent pure acetic anhydride per day and 200 tons of nitric acid/ammonium nitrate nitrolysis mixture per day. Steam is also a major manufacturing requirement, and part of the project package will be a pair of coal-fired steam boilers producing 500,000 pounds of steam per hour and a standby boiler producing 250,000 pounds per hour. Additional major elements in the facilities package include acid recovery facilities, chemical preparation facilities, waste treatment facilities, support facilities, and utilities.

Design for the RDX/HMX complex actively started on 13 December 1974 with the award of a $96,647 contract for preliminary criteria development to The Ralph M. Parsons Co. This was followed by a second criteria development contract (DACA87-75-C-0041) worth $990,789 awarded to Parsons on 14 April 1975. By the beginning of 1977, this contract had acquired eleven modifications and had risen to a cumulative total worth of $3,841,387. All criteria had been completed by January 1977 with the exception of the nitric acid concentration plant and the Line 1 recrystallization building.[20]



RDX/HMX Production Facility. The Ralph M. Parsons Company

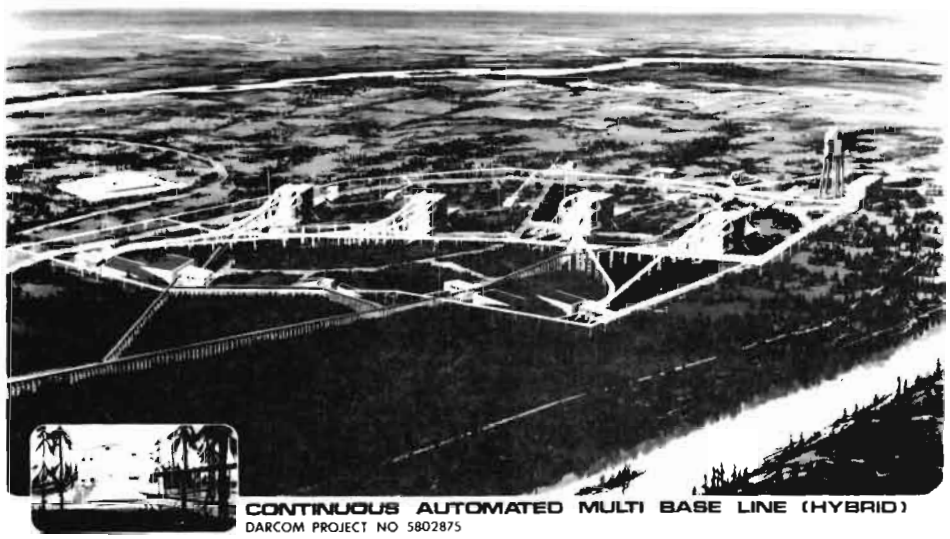
Groundwork for concept design and final design of the RDX/HMX facilities was just beginning as this **History** was being written (January 1977). During the next two years, several AE design contracts will probably be awarded, and construction for parts of the complex will begin in 1979. Certain constituent elements such as the nitric acid production plant and the acetic anhydride plant will be designed and constructed under single "turnkey" contracts. At the beginning of 1977, Division staff was drafting an AE advertisement for **Commerce Business Daily** for RDX/HMX Line 1. The only RDX/HMX AE contract that had been awarded was to J.E. Sirrine on 11 June 1976 for the preparation of Steam Plant Equipment detail specifications in advance of procurement. This project bears the MPBSCP number 5802668-01 and has a programmed cost of $18,200,000.[21]

As exemplified with the RDX/HMX expansion project above, the Army has been attracted to the possibilities of producing explosives on continuous and automated lines instead of by batch process. The Continuous Automated Multi-Base Line (CAMBL) hybrid now in the design development stage for Radford AAP, Radford, Virginia, and Sunflower AAP, De Soto, Kansas, is another example of the implementation of this concept. Current equipment at these plants is of World War II vintage, Radford having been built originally in eight months in 1942 and Sunflower AAP in about the same time. Now programmed for FY 1980 construction award, the Radford-Sunflower CAMBL hybrids will offer continuous and automated output of the high demand double-base and triple-base propellants ("cannon powder") used in large calibre artillery pieces. The advantages of the process over traditional batch production are several. Perhaps the most significant advantage is that operating personnel can be reduced by 80 percent which will substantially reduce the labor costs of the product and diminish operator exposure

to dangerous materials handling. Better product quality and uniformity should result, too, because the elimination of batching will also eliminate the customary need to blend batches to obtain uniform performance characteristics.[22]

Evolution of the CAMBL concept began at Radford AAP about 1970. Working in conjunction with Hercules Powder Co., the plant's operator, ARMCOM funded MM&T studies of a pilot line to prove out the equipment in full-size configuration. Ballistic tests on the first pilot lots of M26 double-base powder were nearing completion in November 1976 with triple-base tests to follow. With its entrance into the MPBME in 1974, Huntsville Division joined Hercules in developing criteria for production CAMBL facilities on an in-house basis. This was one of the first instances of Corps of Engineers participation in MPBME projects at the criteria stage. Formerly, Corps constructing organizations had not been privy to projects until the design phase, too late to incorporate earlier lessons learned or to jointly design two or more similar projects at different locations. The preliminary Huntsville-Hercules criteria were subjected to a $94,000 value engineering study conducted by Zurheide-Hermmann, Inc., beginning 27 June 1975, and topographic investigation into potential sites at Radford began about the same time. This study resulted in a savings of $3.5 million. Criteria development for the CAMBL concept was completed in mid-December 1976, and concept design was scheduled to begin at the first of March 1977.

Since the Radford and Sunflower CAMBL hybrids have identical processes and products with only minor site peculiarities, the criteria for both installations have gone forward concurrently. Both CAMBL facilities will utilize an alcohol and acetone solvent-type process to make M26 double-base propellant out of nitroglycerine and nitrocellulose feedstock originating on-site. Alternatively, the lines may be directed to produce triple-base M30 or M30A1 powders from nitroglycerine, nitrocellulose, and nitroguanidine. Nitroguanidine stock is currently wholly imported from exclusively Canadian sources, but a MPBME project is underway to provide for domestic manufacture at Sunflower AAP. The basic manufacturing for either double-base or triple-base powders is similar and may roughly be divided into three stages. In the CAMBL hybrid, the first two stages are automated, and existing conventional facilities will be used for the final stage, bringing construction cost savings of 50 percent over wholly new facilities.[23] In the first stage, the chemical ingredients and alcohol-acetone solvents are prepared in separate facilities. One chemicals preparation and one solvents preparation building each serve two "Green Lines." Each "Green Line" has two independent production channels. In the "Green Line" area, the heart of the process, the chemical ingredients are mixed under rigid computer control to emerge as a moist dough. The mixture is extruded through dies and cut to form "green" grains of powder. In the third or finishing stage, the uncured powder is loaded onto two-inch deep trays with perforated bottoms and conveyed to a forced air drying building to remove all traces of solvent. The dry powder is then glazed with powdered graphite and packed in fiber cans for distribution. The CAMBL will "sense" the level of volatiles and moisture so well that blending of powder batches will be superfluous.[24]



Continuous Automated Multi Base Line (Hybrid).

The Radford CAMBL hybrid is an expansion project currently programmed for FY 1980 construction award. When completed, this installation will have four "Green Lines," each with two independent process channels, amounting to a total of eight lines of independent primary manufacture. Two solvent preparation/chemical preparation buildings, a control house, tank farm, and miscellaneous support facilities are included in the project. Radford's CAMBL will generate an additional capacity of 2.4 million pounds of M30 powder per month to the plant's present capacity of 1.3 million pounds per month. The Radford CAMBL proper is being managed by Huntsville Division and has an anticipated construction cost of $52,774,000. Included in this figure is $2 million worth of rehabilitation for existing drying, finishing, pack-out facilities being designed by the Norfolk District.

The Sunflower CAMBL project will result in six new "Green Lines" (twelve independent production modules) to replace either existing "B" or "C" batch line, which will be scrapped. The new CAMBL will have a capacity of 3.6 million pounds per month of M 30.

The Sunflower CAMBL design is being managed by Huntsville Division in unison with the Radford project and has an estimated construction cost of $78,322,000. Out of this figure, $16 million will be directed toward a refurbishing of existing drying, finishing, and pack-out facilities being designed by Kansas City District.[25]

An important aspect of the modernization of the Sunflower AAP, as well as other P&E plants, is the improvement of acid plants which serve the preparation of chemical feedstock. Both nitric and sulfuric acids may be used in explosives manufacture, and in most operations these chemicals must be recovered and reconcentrated in facilities separate from the production line. In the MPBME the acid treatment facilities represent a special area of concern reflected in their high priority within the program. In a great many cases, the existing plants have patched up equipment based on antiquated technology that blocks further modernization or expansion. Inefficient and unreliable, these old acid plants are also sizeable facilities that are costly to replace. Their replacements, however, must not only be harmoniously integrated with the older existing facilities and with future planning but today must also meet stringent state and federal parameters regarding pollutant discharge. The design and construction of acid plants, therefore, represent particular challenges which are often met by solicitation and evaluation of technical proposals, followed by award of a unified ("turnkey") design-construction contract.

Generally typical of acid plant projects at all eleven GOCO P&E plants, the Nitroguanidine Sulfuric Acid Concentration System (SAC) at Sunflower AAP is also uniquely related to the overall munitions base and to the manufacture of triple-base cannon powder described earlier. The SAC is part of an urgently needed domestic complex that will replace the current Canadian source of nitroguanidine feeding Radford, Sunflower, and other multi-base propellant lines. The $92,700,000 (1975 estimate) complex was approved and funded on 30 June 1975, and design procedures were inaugurated immediately.

The Nitroguanidine SAC project 5752632-04 provides for a sulfuric acid concentration facility capable of concentrating a weak 70 percent sulfuric acid feed solution containing water and chemical salts into a concentrated 93 percent acid product. The stream feeding the concentrator will be a waste stream leading from the nitroguanidine production facility and will return reconcentrated sulfuric acid to the nitroguanidine process line. Technically, the Nitroguanidine SAC amounts to a species of still in which incoming weak acid is directed into vacuum chambers. The atmosphere is then evacuated and the chambers heated through steam coils to drive off water in the acid. A major techincal problem is that the weak feed sulfuric acid has to be concentrated in the presence of by-products of the manufacturing process such as guanidine sulfate, guanidine nitrate, and nitroguanidine residues. It was desired that these compounds should remain unaffected by the concentration, yet the application of heat tends to decompose the guanidine compounds present with the acid. The contractor for the SAC "turnkey," therefore, has only to demonstrate that the plant will concentrate acid from 70 percent to 93 percent but not to show that the nitroguanidine salts would be unaffected.[26]

The formulation of design criteria, design, and construction in this project reflected the novelty of the nitroguanidine process and the intricacies of providing a smooth transition from the drawing board to prove-out of the finished plant. Decisions taken in the MPBME Project Office at the inception of the Sunflower Nitroguanidine SAC procurement in 1975 dictated that the facility should be designed, engineered, constructed, and performance proved by one firm under a single "turnkey" contract. In turn, the IFB for this contract had to contain an explicit technical proposal amounting to the criteria upon which bids could be offered. The first step for Huntsville Division, therefore, was to develop a Request for Technical Proposals (RFTP). To support this Request and later evaluation of the proposals submitted, the AE firm of H.K. Ferguson was engaged on 19 September 1975. Subsequent evaluation of

Ferguson's RFTP, plus resolution of differences with the Project Manager's Office, consumed all of 1976, and it was not until 26 December 1976 that the Division was able to issue its RFTP. During 1977 it is expected that the Technical Proposal will be chosen, to be included with the IFB to be issued later in the year.[27]

Metal parts projects in the MPBME are fewer in number than either P&E or LAP projects, and because metal parts plants present lesser pollution problems or operator hazards, they have generally received a lower priority than P&E or LAP AAPs. Nevertheless, modernization and expansion of metal parts plants are equally vital to the nation's munitions manufacturing base. Normally, metal parts that can be produced by private industry are procured from that sector, but there are many large items that industry does not manufacture in quantities sufficient to satisfy overall Army needs. These large, high demand items are now, or can be, manufactured at Burlington, Gateway, Hays, Riverbank, St. Louis, Scranton, Louisiana, and Twin City AAPs. The MPBME program will give these plants new material-handling equipment, furnaces, lathes, drill presses, and milling machines. Control of many of these will be automated with easy adaptation to new and different metals or innovative processing as these appear. Potential benefits to be derived from modernization will include a better quality product, greater productive output, diminution of the scrap rate, reduction of unit cost, reduction of operating staff, greater safety, better control of pollutants and waste products, and higher employee morale.

The 105-mm Projectile Metal Parts Manufacturing Facility 5762532T developed for Lone Star AAP was one of the more notable metal parts projects managed by Huntsville Division to date. Despite its exceptionally large $60,300,000 price tag (30 September 1976 current working estimate) and its uncertain future, the nature of the Lone Star project is quite typical of metal parts modernization and expansion everywhere. The genesis and evolution of project design are also typical of the way Huntsville Division has usually functioned in the MPBME, since the project criteria were generated by the AAP contractor-operator and design was carried out by the Division.

The Lone Star AAP at Texarkana, Texas, is a typical World War II vintage GOCO plant presently operated by Day and Zimmermann. Today it is not a metal parts plant per se but one of the Army's more important LAP facilities, producing loaded 105-mm artillery shells, 81-mm mortar rounds, grenades, mines, CBU, primers, and detonators. If the new 105-mm Projectile Production Facility is constructed--and this currently seems somewhat problematical--the installation will give Lone Star a metal parts function. The facility will provide an up-to-date source of one million projectiles per month for LAP lines on the premises and for supply to other LAP AAPs. Consideration has also been given to expansion to handle future generation medium calibre alloy steel (HF-1) projectiles.[28]

Project 5762532T comprises all the manufacturing elements necessary to convert 1000 pound rounded corner mild steel billets measuring four inches by four inches by twenty feet into finished 105-mm artillery projectiles ready for their explosive filling. For the Lone Star AAP, design calls for a billet storage yard measuring seventy-five feet by 1,000 feet served by a seventy-five ton crane and several smaller cranes. Up to a ninety days' supply of raw material may be stored in this yard. Adjoining the billet storage yard is the Projectile Building itself, approximately 300 feet wide, 1,500 feet long, and thirty feet high. The first part of the production line will be devoted to initial heating and forming operations. Cold steel billets removed from storage will first enter one of five identical independent electric induction heating tunnels where they will be heated into a red-hot softened state at 2,050°F. Upon emerging from the tunnel, a 350-ton shear blade will trim off hot slugs of predetermined length. These blanks will next travel to one of fire 2,000-ton capacity hydraulic presses. In two rapid operations these presses will form a "cabbage" tapered at one end and indented at the other. The projectile blank now taking shape will be further drawn through dies to reduce its diameter and increase its overall length, leaving enough outside material for machining and forming operations which follow. Press and drawing machines are to be fitted with automated controls which will both move the workpiece and sense its temperature to avoid damage to process equipment through excessive strain.

After emerging from initial forming operations, the shell forging will be cooled, shot-blasted to remove scale, and automatically chucked on duplex lathes. The first turning operation will give the slug body a rough contour turning; nose contours will then be developed by reheating and shaping in a 400-ton vertical press containing a nosing die. Final finishing operations include several further lathe treatments to give the shell its finished dimensions and a circumferential groove for the bore sealing band. Fuze threads in the nose are also cut at this stage. After washing, the projectile is completed by automatic welding of the

base plate, final bourrelet grinding, and application of the bore sealing band. Stamping of nomenclature, lot number, date of manufacture, contractor code, and protective painting result in a finished product ready for transmittal to LAP operations. Facility production rate will be 2,000 per hour, which on a three shift, 120 hour work week amounts to about one million projectiles per month.[29]

Active planning for a 105-mm facility like the one just described started in 1973 when the MPBME Project Manager's Office selected Lone Star AAP over the St. Louis AAP as facility site and notified plant operators Day and Zimmermann to initiate criteria development. The facility was to be funded with FY 1976 monies, meaning that construction would get underway sometime after July 1975. Day and Zimmermann released their baseline criteria to OCE on 13 August 1974. Huntsville Division actively assumed management of the project for design purposes in September 1974, and on 9 December 1974 Lockwood Greene Engineers, Inc., were awarded AE contract DACA87-75-C-0032 in the amount of $1,173,815 to produce a facilities design based on Day and Zimmermann criteria. Design passed smoothly through concept and final design phases with all milestones being met on time, despite several criteria revisions and seventeen modifications to the Lockwood Greene contract. Final design was completed on schedule in December 1975, but before the project could be advertised for construction in May 1976, Congressional action intervened. The House of Representatives Appropriations Committee recommended deferral of the project and requested a study of the feasibility of using or modifying facilites at St. Louis AAP. At the end of 1976 the Department of the Army was reviewing the St. Louis alternative, and no prediction could be made regarding the decision that would be made.[30]

In addition to the large MPBME modernization and expansion projects mentioned above, Huntsville Division has also exercised a managerial role in the area of PS&ER projects. While geographic districts prepare the criteria, design, and construct these projects, Huntsville Division maintains the milestone reporting on them and offers design review and assistance if required. The vast majority of PS&ER jobs are relatively modest in dollar value and usually do not reflect the kind of spectacular technology sometimes found in MPBME projects. A random selection from the Division's omnibus listing in the MPBSCP "Planning & Design Status Report" (30 September 1976 edition) reveals projects such as 5775314-14, a $21,000 telephone cable installation at Louisiana AAP; 5785317-17 for reroofing of buildings at Milan AAP worth $83,000; and 5785312-20, a $139,000 installation of guard station and truck scales at Volunteer AAP.[31]

CHAPTER VI FOOTNOTES

[1]Lenore Fine and Jesse A. Remington, **The Corps of Engineers: Construction in the United States** ("The United States Army in World War II," The Technical Services [Washington, 1972]), pp. 529-530.

[2]Thomas H. Blunt, Sr., "Modernizing Our Munitions," **The National Defense,** Nov.-Dec. 1973, pp. 250-252.

[3]Ibid.

[4]U.S. Army Audit Agency [Audit] Report MW 73-62, "Report of Audit: Audit of the Army's Production Base Support Program," 31 May [1973, p. 5.

[5]Ibid., pp. 6-8.

[6]"Production Manager Charter, Munitions Production Base Modernization and Expansion," 8 Sep 73, p. 1. USAEDH-DE [file, Munitions Production Base Program 1501-07.

[7]Memo for Record, Col Peter Grosz, Jr., Dpty Div Engr, 25 Jun 73, sub: Army Munitions Plants Modernization and Expansion. USAEDH-DE file, Munitions Production Base Program 1501-07. Ltr, Lt Col John J. Cook, Assist Div Engr, to Col Lochlin Caffey, Div Engr, 6 Sep74, sub: Munitions Production Base Support Construction Program (MPSCP) Resources Management System. USAEDH-DE file, Munitions Production Base Program 1501-07.

[8]Memo for Record, Col Peter Grosz, Jr., Dpty Div Engr, 25 Jun 73, sub: Army Munitions Plants Modernization and Expansion. USAEDH-DE file, Muntions Production Base Program 1501-07.

[9]Ibid.

[10]Note, Col Lochlin Caffey to Gen Burnell, 10 Sep 73, sub: Assumption of Munitions Mission. USAEDH-DE file, Munitions Production Base Program 1501-07.

[11]USAEDH, "Plan for Corps of Engineers Support to Army Materiel Command for Ammunition Production Base Construction Program," Sep 73. USAEDH-DE file, Munitions Production Base Program 1501-07.

[12]USAEDH-PAO, "Information Bulletin," VI, No. 9 (15 Oct. 1973), p. 1.

[13]Ltr, Maj Gen D.A. Raymond, Dpty Chf of Engrs to Div Engr, Huntsville, 20 Nov 73, sub: Corps of Engrs Support to Army Materiel Command for Munitions Production Base Support Construction Program (MPBSCP), with inclusion "Instructions for Corps of Engineers Support to Army Materiel Command Munitions Production Base Support Construction Program," 20 Nov 73. USAEDH-DE file, Munitions Production Base Program 1501-07.

[14]Memorandum of Understanding Between the Project Manager for Munitions Production Base Modernization and Expansion (MPBME) and the Corps of Engineers for Support of the MPBME Construction Program," signed by Brig Gen Robert J. Malley, Project Manager, on 11 Dec 74, and by Maj Gen George A. Rebh, Director of Military Construction, on 15 Jan 75. USAEDH-DE file, Munitions Production Base Program 1501-07. OCE, "Operations Manual for Munitions Production Base Support Construction Program (MPBSCP)," 13 Sept. 1976.

[15]Ltr, Maj Gen D.A. Raymond, Dpty Chf of Engrs, to Div Engr, Huntsville, 20 Nov 73, sub: Corps of Engineers Support to Army Materiel Command for Munitions Production Base Support Construction Program (MPBSCP). USAEDH-DE file, Munitions Production Base Program 1501-07.

[16]The early map of project manager areas of responsibility is in USAEDH-DE file, Munitions Production Base Program 1501-07. For further reorganizations within the Engineering Division, see the tables of organization in USAEDH-PAO, "Historical Summary FY 1974," II, Documents, pp. 2-26, and USAEDH-PAO, "Historical Summary FY 1975," II, Documents, pp. 6-25.

[17]Memo to the author from Thor S. Anderson, Chief, Procurement and Supply Division, USAEDH, July 1978.

[18]The sources for the development of the Mississippi AAP include: personal interview with Carl Manley, Project Engineer, Project Management Branch, Engineering Division, USAED, May 1978; USAEDH-DB, "Planning & Design Status Report: Production Base Support Projects," 30 Sept. 1976, 4 Feb. 1977; Contract Records file, USAEDH AE Contracts Section, Engineering Division.

[19]The sources for the RDX/HMX project include: personal interview with William Little, Chief, Engineering Division, USAEDH, 7 April 1977; personal interview with Robert K. Sawyer, Chief, Project Management Branch, Engineering Division, USAEDH, 5 April 1977; personal interviews with Ray Segelhorst, Project Engineer, Project Management Branch, Engineering Division, USAEDH, May 1978; USAEDH-DB, "Planning & Design Status Report: Production Base Support Projects," 30 Sept. 1976, 4 Feb. 1977; MPBME Project Manager's Office, "Review and Command Assessment of the Munitions Production Base Modernization and Expansion (Recap)," 11 Sept. 1973, 18 Dec. 1973, 25 Apr. 1974, 19 Sept. 1974, 29 Jan. 1975, 8 Apr. 1975, 29 July 1975, 9 March 1976, 17 Aug. 1976, 16 Nov. 1976.

[20]Contract data for RDX/HMX may be found in the Contract Records file, USAEDH AE Contracts Section, and in USAEDH-

PAO, "Historical Summary FY 1974," II, Documents, pp. 101-102; USAEDH-PS raw input data for "Historical Summary FY 1976," in USAEDH-PAO "Historical Summary" file.

[21]USAEDH-DB, "Planning & Design Status Report: Production Base Support Projects," 30 Sept. 1976, 4 Feb. 1977.

[22]For information on the CAMBL project, I am deeply indebted to Kenneth Edmundson, Project Management Branch, Engineering Division, USAEDH, for very thorough and comprehensive briefing on 7 April 1977 and a further series of conversations during May 1978. Other information may be found in a briefing on the MPBSCP prepared by the MPBME Project Manager's Office entitled "Munitions Production Base Twelve Year Modernization and Expansion Program," 25 July 1973.

[23]The cost savings are figures estimated to the author by Kenneth Edmundson, Project Engineer, Project Management Branch, Engineering Division, USAEDH, in May 1978.

[24]Personal interviews with Kenneth Edmundson, Project Engineer, Project Management Branch, Engineereing Division, USAEDH, May 1978.

[25]Personal interviews with Kenneth Edmundson, Project Engineer, Project Management Branch, Engineering Division, USAEDH. May 1978; USAEDH-DB, "Planning & Design Status Report: Production Base Support Projects," 30 Sept. 1976, 4 Feb. 1977.

[26]Personal interviews with Henry O. Everitt, Project Engineer, Project Management Branch, Engineering Division, USAEDH, June 1978.

[27]Personal interviews with Henry O. Everitt, Project Engineer, Project Management Branch, Engineering Division, USAEDH, June 1978; USAEDH-DB, "Planning & Design Status Report: Production Base Support Projects," 30 Sept. 1976, 4 Feb. 1977.

[28]The information for the 105-mm Projectile Metal Parts Manufacturing Facility has been derived from personal interviews with Sam B. Presson, Project Engineer, Project Management Branch, Engineering Division, USAEDH, July 1978; "Design Criteria: 105-mm Projectile Manufacturing Facility Modernization Project AMC 5762532" prepared by Day and Zimmermann, Inc., plant contractor-operator for Lone Star Ammunition Plant; MPBME Project Manager's Office, "Status Report: 105-mm Projectile Facility, Lone Star Army Ammunition Plant Project No. 5762532T," No. 6 (4 Aug. 1975) and No. 7 (undated).

[29]"Design Criteria: 105mm Projectile Manufacturing Facility Modernization Project AMC 5762532" prepared by Day and Zimmermann, Inc., LSAAP, including all revisions.

[30]USAEDH-DB, "Planning & Design Status Report: Production Base Support Project," 30 Sept. 1976, 4 Feb. 1977; Contract Records file, AE Contracts Section, Engineering Division, USAEDH.

[31]USAEDH-DB, "Planning & Design Status Report: Production Base Support Projects," 30 Sept. 1976.

CHAPTER VII

THREE NEW MISSIONS FOR HUNTSVILLE DIVISION

In the history of Huntsville Division, the years 1974, 1975, and 1976 were years principally marked by a growing diversification of tasks, a characteristic that was first manifested with the Postal mission in 1971 and which has since grown more pronounced in the post-ABM Treaty era. Born a division with a unique and exclusive dedication to ABM facilities design and construction, the Division has now become an organization with a spectrum of civilian and military mission assignments. The assumption and course of some of these post-SAFEGUARD missions have already been explored in previous chapters. This chapter deals with the history of three other missions assumed during 1974-1976: the ERDA fossil fuel coversion program, the Jordanian Armor Rebuild Center mission, and the Saudi Arabian GFP procurement program. Each of these recent tasks is stamped with a high degree of individuality and draws on the engineering, procurement, and management skills and systems developed from previous or on-going mission assignments. And while it may fairly be said that up to 1977 all three of the missions have been relatively modest in size, at least one, the Saudi Arabian procurement, holds the promise of setting new records for the Division and the Corps in terms of dollar value and international implications.

I. In Conjunction With ERDA

One of the most serious problems confronting the United States in the decade of the 1970's and beyond is what is commonly termed "the energy crisis," a critical and increasing shortage of petroleum and natural gas available for energy and chemical raw material. At the root of the crisis is the fact the United States derives three-quarters of its energy from oil and natural gas and depends heavily upon these minerals for chemicals, fertilizers, plastics, synthetic fibers, and other uses. A soaring demand for the good things that petroleum can produce has steadily driven imports upwards as domestic supplies dwindle. In 1976 petroleum imports amounted to about 35 percent of total consumption, imports which cost more than $30 billion and which had a highly detrimental impact on the nation's balance of trade.

By contrast with the dismal picture of petroleum and natural gas usage, however, the United States has immense proven coal deposits estimated at between 250 and 400 years' supply at current rates of consumption. The utilization of coal to reduce American dependence on oil and natural gas obviously appears to be a promising path in relieving the energy crisis. Despite the richness of reserves and a relatively low pithead price, though, the extensive substitution of coal for petroleum or natural gas had been frustrated by high transportation costs and especially by dirty burning and handling characteristics. Hence, in the face of the energy crisis, conversion of coal into clean, easily moved gaseous or liquid hydrocarbons has generated considerable national interest as a solution to raw coal's drawbacks.

Serious investigation of coal conversion technology in the United States had its real beginning after the Arab oil embargo of October 1973. Prompted by the ominous consequences of the embargo, the Office of Coal Research of the U.S. Department of the Interior undertook research and development programs in advanced coal-fired power systems and in the conversion of coal to clean liquid and gaseous fuels. Since the coal conversion program required the planning, design, construction, and operation of a number of pilot plants and one or more demonstration plants, and since the Department of the Interior had no appropriate engineering support organization, the Office of Coal Research sought the assistance of the Corps of Engineers. Exploratory conversations for support in coal conversion were apparently held with OCE and Huntsville Division during April 1974,[1] and on 30 April 1974 Col. Lochlin Caffey, the Huntsville Division Engineer, and Bernard L. ("Barney") Trawicky, Chief of the Engineering Division, visited the Office of Coal Reserarch to establish an initial working liaison. The next day, 1 May 1974, three representatives from Huntsville Division began informal assistance to the Office of Coal Research in preparing its Request For Proposals (RFP) for a Clean Boiler Fuel Demonstration Plant. This plant was to demonstrate the commercial feasibility of converting bituminous high sulfur coal into a low sulfur emissions ("clean") liquid fuel suitable for boiler firing under contemporary Environmental Protection Agency standards.[2] With this modest unwritten and informal colloberation on the Clean Boiler Fuel Demonstration Plant, RFP Huntsville's ERDA mission may be said to have actually started.[3]

Formalization of Huntsville's assistance with coal conversion followed ex post facto during the next six weeks. On 30 May 1974 Secretary of the Interior Rogers Morton wrote to Secretary of Defense James R. Schlesinger to solicit an agreement whereby the

Corps of Engineers would provide technical and engineering assistance to the Office of Coal Research. Specifically, the Corps would assist in the preparation and review of plans and specifications, bid proposal packages, and cost estimates for construction projects. Army Engineers might also be asked to serve on source evaluation boards and other planning and review committees, as well as to provide on-and off-site quality assurance through supervision of fabrication and construction. Reimbursement for Army efforts would be funded by the Office of Coal Research.[4] After internal review within the Office of the Secretary of Defense, Deputy Secretary of Defense William Clements replied favorably to the Office of Coal Research's request for Corps assistance:

> I have reviewed this matter with the Secretary of the Army, who advises me that the Corps will be able to undertake this program without impairing its ability to carry out currently assigned programs. I am pleased to authorize the Secretary of the Army to have the Chief of Engineers proceed with the negotiation of a definitive agreement covering the services which you desire, the funding arrangements, and the required personnel augmentation.[5]

Deputy Secretary Clements' 18 June letter marked the official beginning of Corps of Engineers participation in the nation's coal conversion programs. As the letter noted, the Chief of Engineers was authorized to negotiate a "definitive agreement" with the Office of Coal Research concerning Corps' services. It further noted that the approval of the Office of Management and Budget would be necessary for funding arrangements. By 6 August the two parties had drafted a "Memorandum of Understanding" for Contract No. 14-32-001-1759 which governed their relationship, but the draft remained unsigned until approval from the Office of Management and Budget was received in the spring of 1975. In the interim the Division was asked to submit estimated manpower and funding requirements demanded by the coal program. Initial figures supplied to OCE on 13 August indicated that under conditions of two demonstration plant contracts managed concurrently, the Clean Boiler Fuel program alone would probably require an average staff of eleven and a peak of sixteen during FY 1975 and an average of thirty-five and a peak of fifty during FY 1976. Costs would be $353,000 for FY 1975 and $1,180,000 for FY 1976. Support for additional Office of Coal Research programs was very ill-defined at the time, but it was thought that "based on the very limited knowledge we have to date, an estimate in the range of 25 manpower spaces, at an expenditure at about 1.0 million dollars annually, will be required to support other OCR programs that may be assigned to HND."[6] Pending Office of Management and Budget approval of these figures, a letter from OCE on 30 August authorized continued support to the Office of Coal Research for its Clean Boiler Fuel RFP.

As Clean Boiler Fuel activities proceeded during the fall of 1974, an important consolidation of Government energy agencies occurred to change the name of the Corps' latest civilian customer. On 11 October 1974 President Ford signed a Congressional act creating the Energy Research and Development Administration (ERDA). In the reshuffling of agencies that followed, ERDA absorbed the functions of the Office of Coal Research, along with most of those of the Atomic Energy Commission and other energy-related bodies. Activities formerly conducted by the Office of Coal Research now came under an ERDA Assistant Administrator for Fossil Energy who oversaw five subordinate divisions. Those devoted to coal technology included a Division of Fossil Energy Research, a Division of Fossil Demonstration Plants, and a Division of Coal Conversion and Utilization. The new agency began functioning on 19 January 1975.

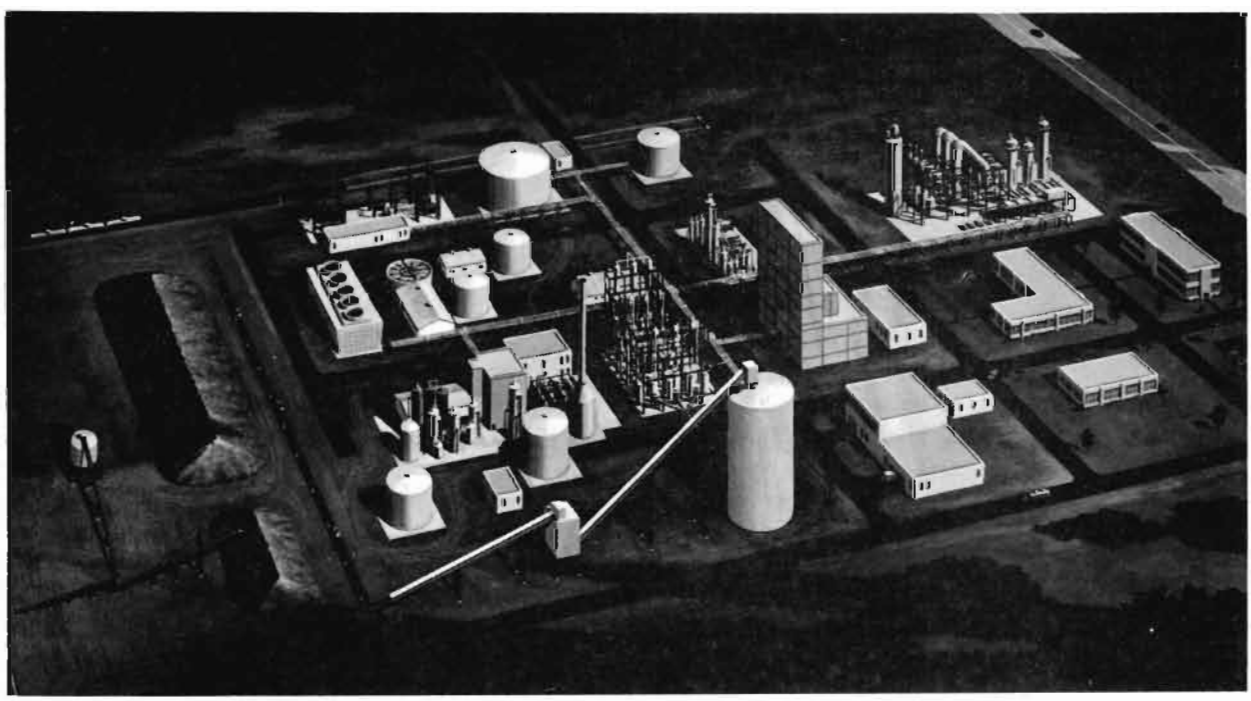
A few months after the creation of ERDA, the Office of Management and Budget gave its concurrence to the ERDA-Corps arrangement. On 18 March 1975 Maj. Gen. George A. Rebh signed the "Memorandum of Understanding" for the Corps, and Dr. Robert C. Seamans, Jr., Administrator of ERDA, executed the agreement on 12 June 1975. While not specifically mentioning Huntsville Division, this document comes as close as any to defining the Division's role in the ERDA mission. According to Article I, ERDA needs were to be met on a task-by-task basis through letters of request directed to the Chief of Engineers, who would forward them to the appropriate Corps field operating agency. Although this implied that OCE had freedom of choice in using any or all divisions and districts for ERDA support, only Huntsville Division as yet has actually had significant fossil energy assignments. Article III defined the primary Corps services to be provided to ERDA:

> The principal technical services provided by the Corps will include, but not be limited to (a) assistance in the preparation and review of plans and specifications, bid proposal packages, and cost estimates of construction projects, (b) membership on source evaluation boards and other planning or

review committees and (c) on-and-off site quality assurance through supervision and inspection of fabrication and construction.[7]

Other services, including legal, procurement and supply, fiscal (comptroller), automated data processing, value engineering, safety engineering, construction laboratories and research work, reproduction, and utilities services support might be provided by the Corps on an individual request basis. Theoretically, then, the ERDA - Corps "Memorandum of Understanding" opened the door to a wide variety of possible Corps of Engineers services as the fossil energy program matured. In fact, however, limited program progress has largely confined Corps participation to assistance in preparation, review, and evaluation of RFP's and cost estimates, all within the purview of Huntsville Division.

In practice, the formation of ERDA in late 1974, the belated concurrence of the Office of Management and Budget, and the conclusion of a "Memorandum of Understanding" in June 1975 made no difference at all to Huntsville Division's functions in the realm of fossil energy. Whether formally sanctioned on inter-agency paper or not, periodic assignments for the Division were made by OCE after 18 June 1974 on the basis of individual task requests from the Office of Coal Research or, later, from ERDA. The first written tasks request made by the Office of Coal Research was for Corps personnel to assist its staff with evaluating design proposals submitted for the Clean Boiler Fuel Demonstration Plant, the most advanced of three coal conversion concepts to be explored in demonstration plant form by the Office. According to the RFP, the plant was to demonstrate the commercial feasibility and economic viability of a chemical process for converting the type of soft, high-sulfur coal common in the eastern United States to No. 6 clean-burning boiler fuel and into substitute natural gas suitable for pipeline transport. Smaller than a hypothetical full-scale commercial facility, the plant was to process 2,600 tons of coal per day to produce 3,900 barrels of liquid fuel and 22 million cubic feet of pipeline quality gas. Sulfur and impurities would be additional by-products.[8]



ARTIST RENDERING of a Clean Boiler Fuel Demonstration Plant.

As it was projected in the summer of 1974, the Clean Boiler Fuel Plant was to be executed in four phases from concept development to normal production status. Eight years were envisioned from receipt of proposals to completion of the plant. Phase I was the preliminary engineering period during which concepts would be proposed by private industry and evaluated by the Government. This phase included both the design of a commercial-size plant and the demonstration plant scaled down from it, some test work, technical studies, site selection, reliability and quality assurance studies, environmental analysis, and documentation and reporting. Phase II was the demonstration plant engineering period during which concepts would be transformed into detailed design engineering. It included preparation of detailed specifications, drawings, and construction bid packages. Both Phase I and Phase II were to be wholly funded by ERDA. Phase III was the construction period from ground-breaking to plant acceptance and checkout. Phase IV was the demonstration plant operation period of several years. During this time the plant would be started up and operated with production variables such as different grades and sizes of coal and the results assessed for further commercial potential. ERDA was to pay 50 percent of Phase III construction costs, plus 50 percent of Phase IV operations expenses for the first forty-two months, at the end of which the contractor would be required to buy out the 50 percent Government interest.[9]

When the Office of Coal Research first solicited technical support from the Corps of Engineers, the Clean Boiler Fuel Demonstration Plant project was at the inception of Phase I. As mentioned earlier, during May and June 1974 three members of Huntsville Division had informally assisted the Office of Coal Research in drafting a RFP for the Clean Boiler Fuel Demonstration Plant to be disseminated in the private industrial sector. The RFP specified the approximate scale of operations, rough technical parameters, and the end products desired while permitting respondents to propose their own design processes. A Clean Boiler Fuel RFP along these lines was issued by the Office of Coal Research on 28 June 1974, with submittals due by 25 September.

The Office of Coal Research received only two Clean Boiler Fuel proposals, one submitted by Coalcon, a joint venture of Union Carbide and Chemical Construction Corporation (Chemico), and another from the Northern Illinois Gas Company (NIGas). Despite this rather lukewarm response, the agency went on to an evaluation of the two proposals. Once again, the assistance of the Corps was solicited in making the review. On 23 August 1974 the Director of Coal Research asked that OCE make available several qualified personnel from Huntsville Division to supplement his staff on the Source Selection Board. The Board was to convene in Washington on 26 September and sit for about three to four weeks. On 30 August OCE approved the request and forwarded it to Huntsville, together with authorization to freely coordinate the choice of personnel directly with the Office of Coal Research. Ultimately, eight representatives from the Division's Engineering and Construction Division staffs journeyed to Washington for the Clean Boiler Fuel Source Selection Board. These men were: William L. Little, William R. Major, Harold L. Watts, Henry O. Everitt, James T. Ammons, William Crow, Carl Manley, and John L. Thompson.[10]

The Source Selection Board's opinion was that NIGas' proposal was nonresponsive as submitted and that only the Coalcon proposal fullfilled the terms laid down in the RFP. This decision freed the Office of Coal Research to negotiate contract terms with Coalcon, and on 17 January 1975 the agency awarded the joint venture contract E(49-18)-1736 worth $237,200,000 for design and construction of the Clean Boiler Fuel Demonstration Plant. Two days later the contract was transferred to the newly-formed ERDA for further administration, where it became program no. BA-07-01.

The process to be used by Coalcon was the Union Carbide Hydrocarbonization Process. In this process the coal is crushed, ground to a uniform particulate size, and fed into a heated and pressurized hydrocarbonization reactor operating at 1040°F and 37 atmospheres pressure. In the reactor the gases in the coal are driven off, and some of the coal reacts with hydrogen gas to form simple hydrocarbons. The residue from the reactor, the char, is used for hydrogen production in the gasifier. Char in excess of that required to produce hydrogen is burned to produce steam. Gas from the reactor is cooled and fractionated, separating the liquids from the gases. The liquids are further refined to produce a clean liquid boiler fuel and other lighter hydrocarbons. The gases are cleaned to remove sulfur, ammonia, and other impurities. By subjecting the gas to extremely low temperatures, butanes, propanes, and similar compounds are cryogenically separated. Hydrogen in excess of that required for methanation is removed and returned to the reactor. The primary product is a clean liquid fuel similar to No. 6 fuel oil. Other products include light oil (No. 2 fuel oil), sulfur, ammonia,

butane, and substitute natural gas. The overall thermal efficiency is approximately 70 percent with a gas/liquid ratio of approximately 50-50 on a BTU basis.[11]

With the award of the Coalcon design-construction contract in January 1975, ERDA believed it could initiate the procurement of some long-lead items needed in the construction phase. On 3 January 1975 the Office of Coal Research asked for Corps support in procuring $10 million worth of long-lead time items for the Clean Boiler Fuel Demonstration Plant. By OCE letter dated 13 January, Huntsville Division was designated as the Corps' Field Operating Agency to carry out the procurement, and on 6 February the Division was authorized to proceed with the procurement using a monthly system of accounting for reimbursement from ERDA funds. Several long-lead items were identified and procurement specifications prepared during the spring. As it turned out, however, this procurement effort proved premature because Coalcon's process design was still fluid. For example, it was not determined until late 1975 that the plant would operate on three kinds of coal or that it would be about one-fifth the size of a commercial plant.[12]

Site selection for the Clean Boiler Fuel Demonstration Plant also began to be developed with the help of Huntsville staff during the spring of 1975. By April site selection was well advanced and preliminary contacts made with interested states. One of the most advantageous locations appeared to be the Peabody Coal Company's River King #3 Strip Mine near New Athens, Illinois. Situated on the Kaskaskia River about forty miles southeast of St. Louis, Missouri, the site offered a large active strip mine with a ready supply of Illinois No. 6 coal and ample water from the river. This site was chosen for the demonstration plant in November 1975, with construction scheduled to start about October 1977.

As the Clean Boiler Fuel Demonstration Plant moved forward on schedule during 1975, ERDA initiated the development of two other coal conversion concepts. Both were explorations of coal gasification and both involved some task assignments to Huntsville Division. The first of these gasification efforts was a Pipeline Gas Demonstration Plant, ERDA program no. BA-07-02. The Pipeline Gas Demonstration Plant was to convert high-sulfur eastern bituminous coal into a clean, high BTU (approximately 1,000 BTU per cubic foot) pipeline quality gas suitable for industrial or residential consumption. ERDA desired that the specific process to be used, the demonstration plant capacity, and the location of the plant all be proposed by the contractor. The demonstration plant would have a capacity between one-tenth and one-half full-scale commercial size.

Most, if not all, of the potential high—BTU gasification process designs offered to ERDA featured certain common steps. The first is pre-treatment of the coal and induction into a coal gasifier. The gasifier was a critical plant component, and ERDA sought gasifiers which would advance the threshold of known technology. In the gasifier, coal is burned in an oxygen-deficient atmosphere, producing a combustible gas plus some undesirable gaseous by-products and solid slag. The combustible gas is tranferred to phase shift equipment where it is reacted with steam. Further processing in a gas cleanup operation yields a pure synthesis gas plus ammonia, sulfur, and carbon dioxide. The pure synthesis gas is separated, passed over a nickel catalyst, and methanated to produce high-BTU pipeline gas (ch^4).

The second of ERDA's coal gasification thrusts was toward a series of three Fuel Gas Demonstration Plants intended for conversion of high-sulfur coal into a clean, low BTU fuel gas (ERDA program no. BA-07-03). Unlike either the Clean Boiler Fuel RFP or the Pipeline Gas RFP, ERDA's Fuel Gas RFP asked for submittals on three kinds of facilities: one to supply fuel gas to industrial consumers, one to supply gas to utilities, and one supplying small scale industrial enterprises. Respondents might answer any, or all, of these categories. As with the Pipeline Gas Plant, the process used and the location were to be proposed by the contractor and reviewed by the Government; again, gasifiers not previously proven might be accepted. Capacities of the Fuel Gas plant were to be based on the results of the process design of a commercial plant reduced to demonstration plant size by a factor of anywhere from one-third to one-eighth.

Coal conversion for fuel gas is generally simpler than for the production of pipeline gas, but the end product is not economically suitable for long distance pipeline transportation because of the relatively low percentage of methane. Generally, the gas must be consumed at or near the manufacturing plant, in effect making the plant an intermediate pollution control facility between the coalyard and the boilers. The initial stage of gasification is similar to the pipeline process, but there are no subsequent phase shift and methanation steps to raise the thermal value of the gas beyond 150-200 BTU per cubic foot. Instead, the gaseous products of initial gasification are cooled, cleansed of sulfur and ammonia, and used directly for power generation, industrial applications, or other uses. Liquids and tars from the gasifier are recycled

through it, and the solid ash is removed as in the Pipeline Gas process.

As with its Clean Boiler Fuel Demonstration Plant, ERDA sought the assistance of Huntsville Division in the early stages of its gasification projects. On 6 March 1975 ERDA forwarded a request to OCE for Corps assistance with three new demonstration plants, the exact nature of which was unspecified but which was understood to include the two gasification plants plus a third conversion concept to be decided later. On 12 June 1975 a followup request was more precise. ERDA asked that the Corps continue to support the Coalcon project design and that it provide for categories of assistance for the Pipeline Gas and Fuel Gas Demonstration Plants. These four areas were:

1. Provide assistance in the preparation of project management plans, reliability and quality assurance plans, configuration management plans, etc.
2. Provide representation at preproposal conferences and assist in the evaluation of inquiries from potential bidders.
3. Participate in the review and evaluation of proposals for the design, construction, and operation of pipeline and fuel gas demonstration plants.
4. Perform special studies relating to facility designs and construction.[13]

As it transpired, Huntsville Divison's involvement with ERDA gasification projects was somewhat more limited than this description implied, mostly because the gasification programs did not go forward as rapidly as expected. During the summer of 1975 the Engineering Division assisted ERDA with preparation of its RFP for the Pipeline Gas Demonstration Plant, and ERDA RFP No. E(49--18)--2012 was duly issued on 3 October 1975. Five technical proposals were received by 20 January 1976. Unlike the Clean Boiler Fuel project; however, no representation from the Division was asked for the Source Evaluation Board that followed. Instead, ERDA personnel scored the technical, managerial, and siting aspects of the proposals, while Huntsville Division staff formed independent Government cost estimates for each proposal submitted.

After about six months of evaluative study, ERDA concluded in mid-1976 that the two best overall Pipleine Gas proposals were those offered by Illinois Coal Gasification Group (ICGG) and CONOCO Coal Development Company (CONOCO). ICGG, a consortium of five Illinois public utilities, offered a concept with Phase I costs of $28,428,000 and Phase II and III combined costs of $292,968,000. ICGG's demonstration plant was to be about one-eighth commerical size. Based on the COED/CO Gas Process, the plant would consume 2,200 tons of coal per day and generate 18 million cubic feet per day of substitute natural gas plus 2,900 barrels per day of synthetic crude oil. The ICGG demonstration plant would be located in Perry County, Illinois.

The CONOCO Coal Development Company is a wholly owned subsidiary of the Continental Oil Company. Its proposal utilized the Lurgi Slagging Coal Gasification Process to convert 3,800 tons of coal per day into 59 million cubic feet of substitute natural gas at an estimated efficiency of 67 percent. The demonstration plant would be sited on several thousand acres of coal-rich lands owned by CONOCO in Noble County, Ohio. CONOCO's total cost estimate for the first three phases of design and construction was $292,178,000. During the second half of 1976 ERDA entered contractual negotiations with ICGG and CONOCO, but due to a schedule slippage of about six months, no contract had been awarded by the end of 1976.[14]

The development of the Fuel Gas Demonstration Plant during 1976 also met with delay and uncertainty. With the support of Huntsville Division, ERDA issued its RFP on 28 January 1976. Industry proposals were returned early in May 1976. Fifteen proposals were received, evenly divided among the three types of plants, utility, industrial, and small-scale industrial. For the Source Selection Board review, R.C. Hellier from Huntsville's Engineering Division joined four ERDA representatives at ERDA's Mound Laboratory at Moundville, Ohio. Eight other representatives of the Division had no vote on the Board but supported its scoring by serving on technical committees. The evaluation for Industrial and Small Scale Fuel Gas Plants was essentially completed by October 1976, but a series of revisions, clarifications, and re-submittals prevented further ERDA action before the end of the year.[15]

After an uneventful start and steady progress during 1975, the Coalcon Clean Boiler Fuel contract began to encounter a morass of difficulties during 1976. Coalcon's original proposal to the Office of Coal Research in late 1974 had been based on about ten years' experience with the conversion of western low-sulfur coal, rather than its high-sulfur, high-caking eastern counterpart. During 1976 experiments with conversion of high-sulfur coal in a very small pilot reaction vessel produced reator clogging and

contaminants in the liquid product, in part because of the small size of the pilot reactor and in part because of the high sulfur content in the coal now being used. These technical problems cast uncertainty on the practicality of scaled-up reactors for the demonstration plant. As these technical problems accrued, Union Carbide's venture partner, Chemical Construction Company, became insolvent, necessitating a reorganization of the Coalcon management. Additional setbacks and disruption were caused by changes in Environmental Protection Agency policy for the amount and type of emissions other than sulfur that might be allowed through industrial burning.[16]

Because of these factors and others, Coalcon undertook negotiations for a new or highly modified contract in May 1976. Coalcon's first revised program was rejected by ERDA, and a redefined scope of work was not arranged until December 1976. As matters stood at the end of the year, Coalcon was to complete and submit its commercial and demonstration plant designs complete through Phase I, with Phases II and III to receive further consideration.

II. The Jordanian Armor Rebuild Facility

The Jordanian Armor Rebuild Facility mission that began in 1975 is one of the most unusual military engineering tasks yet assumed by Huntsville Division. The engineering design requirements for the facility are rather conventional by comparison with some other Division tasks, but the Jordanian facility is distinguished by its overseas location. The facility is the first assignment undertaken by the Division for a foreign customer, and the course of its development to date reflects some of the diplomatic and military complexities associated with United States policy in the Middle East during the mid-1970's. While some unanswered questions about the facility's evolution and use remain, the account that follows is based on unclassified documents in Huntsville Division files and interviews with personnel present during joint military conferences.[1]

American interest in locating an armor rebuild center in the Middle East seems to have begun with Joint Chiefs of Staff situation studies in 1972. After analyzing the armament needs of various nations in the area, the Joint Chiefs concluded that a facility should be located in the region capable of servicing the major types of American and British armored vehicles found in the inventory of some Arab states. Up to this time, depot-level maintenance required the vehicles to be returned to suppliers in Europe and the U.S.A. The primary job of the center would be the conversion of the American-made M48A-1 tanks then equipping the army of the Hashemite Kingdom of Jordan to the M48A-5 model configuration. This was a depot-level undertaking involving teardown, modification, and reassembly of several hundred tanks. In addition to conversion, the depot could accomplish routine depot-level maintenance of the M48 and Centurion tank, armored personnel carriers, armored cars, artillery, and light vehicles.[2]

After conversations with U.S. military advisers, a team of representatives from the Jordanian Armed Forces (JAF) made a six-month inspection tour of the U.S. Army's M48 tank depot at Anniston, Alabama, during the summer of 1972. The Jordanianas were impressed with the assembly line methods found at the Anniston Center. Notes were taken, and the JAF began to formulate plans for building a facility similar to Anniston somewhere in Jordan. Before the project could go beyond preliminary discussions, however, increasing tensions in the Middle East culminating in the Yom Kippur War of October 1973 brought delay to the armor center. In the meanwhile, the Corps of Engineers through its Mediterranean Division began to assist the Jordanian government with other military construction desiderata. In 1972, for example, the Corps recommended three American AE firms to the Jordanian government to build a new general headquarters building for the kingdom's Ministry of Defense and armed forces.[3]

In 1974 thoughts of a Jordanian armor center were revived, and in September of that year initial studies were made by the U.S. Military Assistance Program (MAP) office in Amman, Jordan. Almost immediately it was apparent that the MAP office was not staffed to take on a design and construction task of this type for the JAF. In further discussions between the Department of the Army, Army Materiel Command, and the OCE staff during January 1975, it was found that the Jordanian facility was more a procurement and construction mission than a logictics mission, and that the Corps of Engineers' Mediterranean Divison should be the single project management focus for execution.[4]

Mediterranean Division initiated work by dispatching a small team of representatives to Jordan for field studies on 22-24 March 1975. This team spent two days in the country, contacting American Ambassador Pickering, the MAP office, and at least ten members of the JAF, along with collecting a sheaf of data about contruction costs and conditions in Jordan. The team stated in its trip report that the

facility was "of prime importance to Jordan in that it represents a capability to upgrade their entire armored force through rebuild of on hand US/British equipment rather than purchase new [equipment] which they cannot afford." The team found that the Jordanian military personnel contacted had clear ideas of what was wanted, but it also discovered that "wide divergence of opinions continues between CE and JAF concerning project cost. (15 million dollars JAF vs. 80-100 million dollars CE)." At this stage the JAF desired to negotiate and award its own contract to Corps prequalified bidders, then have the Corps of Engineers manage the actual construction effort.[5]

The matters of contracting and costs were among the subjects of further discussion when JAF representatives conferred with U.S. Army staff in Washington on 21 April 1975. Enough differences were resolved to permit drafting a Foreign Military Sales Case HAA agreement between the countries committing $500,000 of Jordanian funds for the Corps to begin facility design. On the last day of April 1975 an implementing "Technical Agreement Concerning Assistance by the United States Army Corps of Engineers in Design and Constructing an Armor Rebuild Facility for the Government of Jordan" was signed by Maj. Gen. D.A. Raymond, Deputy Chief of Engineers, and Lt. Gen. Sharif Zeid ben Shaker, Chief of the General Staff of the Jordanian Armed Forces. This one-page charter stated that the U.S. Army Corps of Engineers would "provide the engineering and construction management services for the design, engineering, contracting, construction of facilities, and for procurement and installation of equipment" for the Jordanian government. The agreement went on to note that "the Mediterranean Division of the United States Army Corps of Engineers shall carry out these responsibilities on behalf of the CE." For its part, the JAF was to "bear all costs of the services to be provided" through Foreign Military Sales (FMS) procedures.[6] The source of JAF funding was not identified in this document or further correspondence. Annex "A" detailed operating procedures to be respected by both parties, including step-by-step JAF consultation and review.

The above JAF-U.S. agreement of April 1975 stipulated that the Mediterranean Division of the Corps would carry out the Jordanian armor center mission. Mediteranean Division, however, was headquartered in Livorno, Italy, and the Jordanian facility called for specialized expertise in industrial design, construction, and procurement. Frequent contact and close interaction with the American AE firms and vendors were to be expected over a period of several years. Hence, Mediterranean Division looked to a Corps unit based in the United States for support. On 15 May the Mediterranean Division sent a teletyped message to this effect to Huntsville:

> Pursuant to discussions between DEMDD and DEHND on subj[ect] proj[ect] this is formal request for HND to accept responsibility for the design of this project. The project consists of an industrial complex of approx[imately] 17 buildings including full range of machine tools and other industrial equip[ment] to be installed therein, prime duty power plant, plus other utilities, roads, parking, etc. Order [of] magnitude [of] cost is $100 million. The project is funded under Foreign Military Sales (FMS) procedures and initial funding of $500,000 has been authorized by the Jordanian govt. All costs are reimbursable by the host govt; no appropriated funds are involved.[7]

The message closed with the portentous caveat that "there exists at the start of the project considerable difference of opinion on project cost. Jordanian Armed Forces (JAF) believe cost to be in range of $10 million. . .It may be anticipated that project will be tightly funded."[8] The next day, 16 May, a teletyped reply stated Huntsville Division's willingness to accept the mission.[9] Mediterranean Division continued to act as liaison between the parties.

The first step in the armor facility mission was selection of an AE firm to work up a set of criteria based on established Jordanian data. The Annex "A" to the mutual "Technical Agreement" of 30 April governing procedure specified that the name of three or more firms should be submitted to the JAF for approval before award, and on 29 July 1975 a list of four recommended AE firms was forwarded to OCE for review. Giffels Associates, Inc., Detroit, Michigan, headed the list as the Division's first choice.[10] Upon receiving OCE authorization, the list was sent to Mediterranean Division for presentation to Jordanian officials. Jordanian concurrence took about a month, but by message on 10 September 1975 Huntsville Division was notified that the JAF thought Huntsville Division's first choice, Giffels Associates, Inc., was acceptable. Meanwhile, on 10 August the Division was also notified that a site had been selected at Wadi Dalayl on the Amman-Mafraq road.[11] Selection of an AE was completed on 23 October 1975 when

negotiations with Giffels Associates produced contract DACA87-76-C-004. The basic award amount was $205,130, with one option for the initial phase worth an additional $125,525.[12]

For several months after award of the Giffels Associates contract, criteria development progressed smoothly and was generally reviewed with satisfaction on the part of the JAF. Early in November 1975 representatives of Huntsville Division and Giffels Associates traveled to Jordan to consolidate certain elemental decisions about design criteria. At this stage, the production capacity of the center and the number of working shifts the Jordanians wished to employ were only generally known, so Giffels based its design criteria on three presumed production loading models. The Case I model called for annual processing of 943 vehicles or major subassembly rebuilds, of which 145 were tank conversions. Case II assumed the same loading with second shift operations; Case III assumed the same loading with a second shift "in critical high bay operations only."[13] Based on these figures, Giffels drafted an initial design analysis to serve as criteria. Giffels' concept was given its first review at a conference of JAF officers, Giffels representatives, and Corps personnel held at Detroit, Michigan, on 24-26 February. Division Engineer Col. John V. Parish and four members of the Engineering Division represented Huntsville Division; Hugh Tamassia represented Mediterranean Division. Colonel Sayegh and three other lower ranking Jordanian officers present concurred with Giffels' overall facility layout presentation and approved Case I production loading, but they also asserted that the JAF wanted assembly line production methods of the type seen earlier at Anniston Depot, rather than the individual stall system proposed by Giffels. This change necessitated some rearrangement of functional process elements and changes in the dimensions or location of subassembly areas.[14]

Following the initial criteria conference, Giffels' staff proceeded to modify their proposals to incorporate the changes asked by the JAF. In March several communications between the parties strongly indicated that the JAF wanted to commit itself and $5,500,000 in funding for final design and long-range procurement before 1 June 1976.[15] On 4 May Giffels' revised initial criteria were delivered to the JAF, and a last review conference was scheduled for 8-9 June to obtain JAF approval prior to final design contract award. At this conference, the JAF officers present "voiced dissatisfaction with both the estimated construction costs and the design schedule,"[16] but they continued to indicate a firm desire to start final design in late June or early July, pending receipt of negotiated final design costs and schedule.[17]

By message to the MAP office in Amman on 25 June 1976, Huntsville Division forwarded estimated AE costs of $3 million, including facility final design, industrial equipment specifications, and design of special tooling and fixtures. Rough site grading and warehousing would add approximately $1,500,000. The message went on to conclude that "the [total] construction cost estimate of $109M is the result of the best effort of the AE, thoroughly checked by USAEDH." Several cost factors in lower Jordanian estimates were questioned, such as neglect of the influence of inflation over eighteen months' construction time, the inclusion of heavy lifting and tow equipment, ambulances and fire vehicles, and special jigs and tooling, "It is our opinion," the communication observed, "that the JAF doesn't recognize the full scope and complexity of the project."[18]

For unknown reasons which may have been related to costs, the JAF position took a surprising volte-face in early July. On 6 July a puzzling message to the Department of the Army from MAP in Amman requested:

> your assistance in getting the Jordan Armor Rebuild Facility project back on track. At meeting on 5 July with JAF representatives, they indicated their displeasure with the project. In delving into the various problem areas, it was obvious that we were in no position to respond to their grievances, misunderstandings and disagreements with the present and future progress of the project.[19]

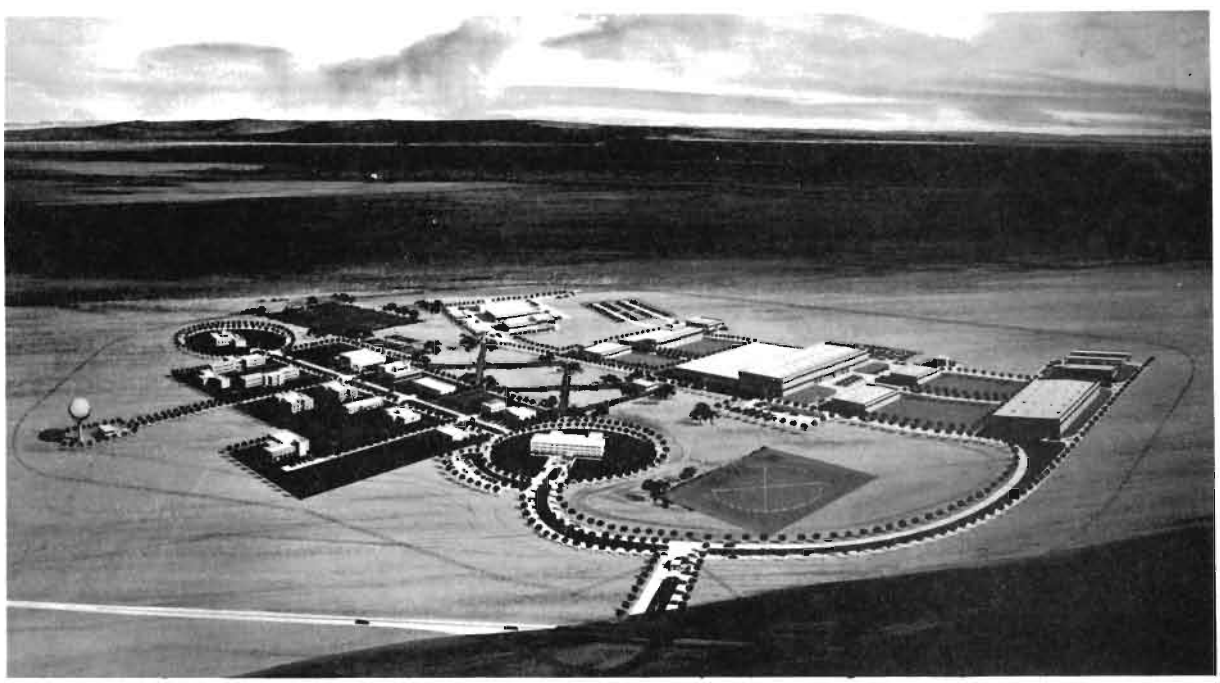
The MAP office's suggested solution was a conference in Washington in August to be comprised of Jordanian Maj. Gen. Abdul-Haddie al-Majali, Assistant Chief of staff, and comparable rank officers from the U.S. Army that would be empowered to make binding decisions. Upon inquiry from Mediterranean Division, Huntsville Division replied that "we feel Reference A [the message above] was caused by some misunderstanding," but this not withstanding, "USAEDH strongly feels all attempts at early resolution should be made and offers to travel to Mediterranean location of your desire to assist."[20]

The Washington conference met at OCE in Washington, D.C., on 13 August. Here eyebrows must have gone up when General Majali unexpectedly presented a drastic downward revision of the desired facility's production capacity by 30 to 40 percent. He also presented numerous other major deletions in the interest of cost, such as landscaping, lawn irriga-

tion, perimeter fencing, test track, nine months' spares storage, all industrial vehicles, and three ancillary buildings. To permit incorporation of these changes, the Jordanian officers requested that the Corps present a new concept study and cost estimates. The revised Giffels Associates study and new estimates were to be reviewed with the JAF at an interim briefing in the middle of October, and a final presentation of revised concept and cost estimates would take place in December. Authorization for final design award was now projected for January 1977.[21]

In accordance with JAF wishes, Huntsville Division negotiated revised concept studies with Giffels Associates during the month of September. On 17 September Giffels agreed to contract modification P0005 for $94,356, bringing the total for their AE services to $394,824.[22] Time was now too short, however, to allow a thorough reappraisal of costs and concepts to be made in time for the October meeting of the joint military conference. When advised of this, the JAF agreed that the Corps could "present at the JMC your generalized concepts and related envelopes of potential cost savings associated with reductions."[23] As it turned out, the cost savings resulting from the August scale-down were quite substantial. At the conference held on 15 October, the JAF was informed that according to Giffels Associates' latest "ballpark" figures, the facility's cost was now reduced to about half of the June report, or $55-60 million. By mid-November Giffels had compiled a more refined initial design analysis, and the firm indicated a "bottom line" figure below $50 million.[24]

On 8-9 December another meeting of senior ranking Jordanian and U.S. officers convened at Giffels Associates' Detroit office to hear an anticipated JAF approval for a "go-ahead" on final design. Maj. Gen. Majali again headed a five-man Jordanian party; the U.S. Army was represented by Maj. Gen. Louis Rachmeler, Col. John V. Parish, Jr., Col. Clarence Mann, and civilian personnel from Huntsville Division and from the newly-established Middle East Division based at Riyadh, Saudi Arabia. As had happened previously, however, the agenda produced some surprises. Giffels' revised concept figures now showed a current estimated construction costs of $62.2 million, including materials handling equipment.[25] But instead of accepting this estimate and approving final design, the Jordanian officers now advised that the original primary function of the center, conversion of M48 tanks, was to be dropped, along with depot capability for certain British armored cars. The armor facility's primary mission was to become depot-level rebuilding of the British Centurion tank, and M48 depot-level maintenance dropped to second priority.[26] These parameters required yet another delay to allow Giffels to make adjustments to cope with the Centurion configuration. As of the end of 1976, an award for final design was planned for February 1977. Considering the history of the project, however, it is possible that further revision and consultations will take place before full customer satisfaction is obtained and final design proceeds.

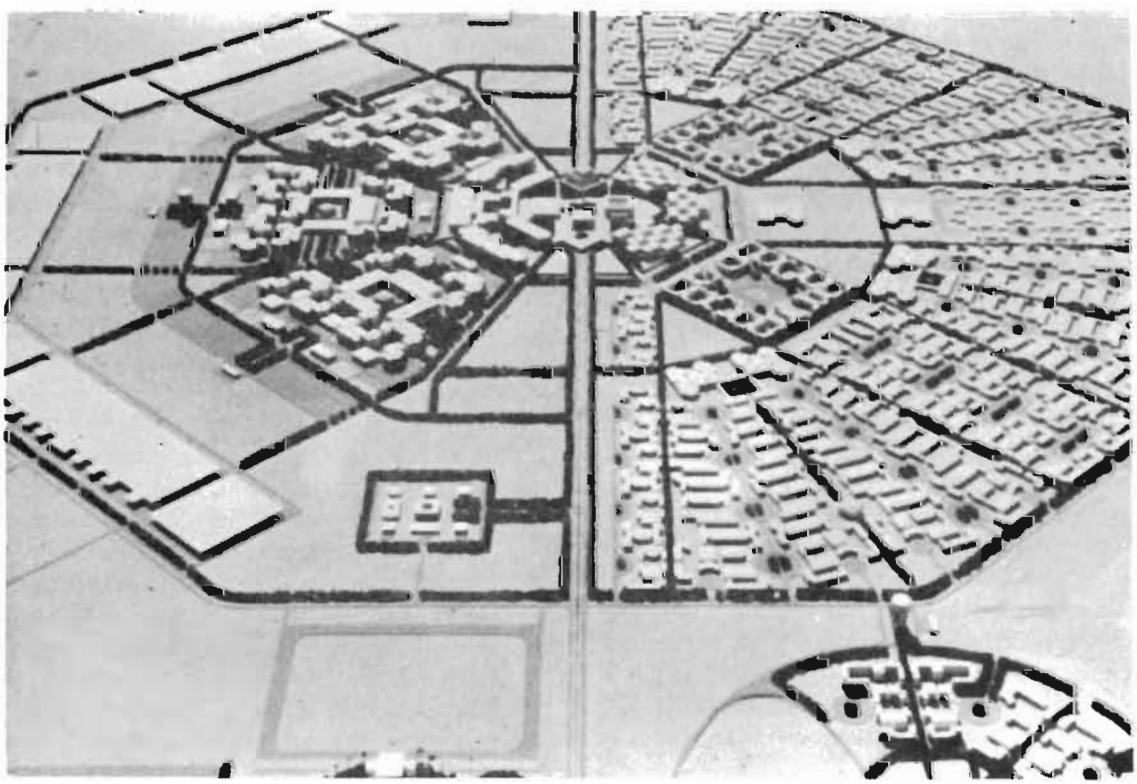


ARTIST RENDERING Of the proposed Jordanian Armor Rebuild Facility.

III. The Saudi Arabian GFP Mission

One of the least known and appreciated, yet potentially most crucial, roles being played by the Corps of Engineers in the mid-1970s is its role in assisting the Kingdom of Saudi Arabia in modernizing their nation. Endowed with immense mineral riches in the form of perhaps 40 percent of the world's proven petroleum reserves, Saudi Arabia also occupies a strategic geopolitical location astride the major oil routes into and out of the Red Sea and Persian Gulf. The country's socio-economic evolution and political future are of great interest to the West. Presently a thinly populated monarchy with what is usually termed a developing economy, Saudi Arabia's leaders have demonstrated a vigorous determination to use their new-found wealth to create a modern industrial economy on the Western model. In the course of self-realization, Saudi Arabia had increasingly turned to the United States for inspiration and assistance in education, medicine, transportation, city planning, technology, and military affairs. The drive to modernity has led to a large Corps of Engineers presence in the country; in turn, the presence of the Corps led to a Saudi Arabian GFP mission for Huntsville Division in 1976.

Today's presence of about 750 Corps personnel in Saudi Arabia began in the late 1950s with minor military assistance. In 1959 the U.S. Army paved a gravel airstrip built during World War II at Dhahran and constructed an ultra-modern terminal building there. In May 1965 a formal agreement was signed between the Saudi Arabian Government and the Corps of Engineers for further engineer assistance. Some of the first projects undertaken were a TV broadcast system for the Kingdom, a cantonment located at Khamis Mushayt in the southwestern part of the Kingdom, and a cantonment at Tabuk in the northwestern part of the Kingdom. Current Army engineer assistance projects include the strategically important King Khalid Military City, a cantonment in the northeastern part of the Kingdom which is a totally new urban settlement of 60,000 complete with its own port at Ras el Mishab on the Persian Gulf 180 miles away. The King Khalid Military City is officially estimated to cost about $7 billion. As part of the Saudi Naval Expansion Program (SNEP), the Corps is constructing a naval base at Jeddah on the Red Sea and at Jubail on the Persian Gulf, as well as a headquarters in Riyadh. A headquarters facility for both the Air Force and National Guard is underway. The Corps is also constructing medical centers at Al Kharj and Riyadh and a military academy complex, also near Riyadh. The funds for these projects, including all Corps administrative expenses, are provided by the Saudi Arabian government.[1]



King Khalid Military City

As the volume of Corps contracts in Saudi Arabia mounted to major proportions after 1973, it became apparent that a reorganization and strengthening of overtaxed procurement elements was in order. Almost all of the GFP equipment and materials destined for Saudi Arabian contracts originated in the United States, and included in it were large quantities of long-lead procurement items. The Mediterranean Division based in Livorno, Italy, with its Saudi Arabia District in Riyadh, had responsibility for the Arabian peninsula, but the Division was neither conveniently located nor adequately staffed for the vast volume of goods that would be required for the construction in Saudi Arabia. Nothing could be done about the 5,000 mile communication lines, but a reorganization of responsibilities might bring about shorter delivery times.

The Corps began realignment of procurement responsibilities for the Saudi Arabian GFP task in January 1976 when Lt. Gen. William C. Gribble, Jr., the Chief of Engineers, decided to bring the Huntsville Division into Saudi operations for support in the area of GFP procurement. The decision was based on the extensive expertise and experience gained through the SAFEGUARD and Postal GFP procurements which were unparalleled in the Corps of Engineers. General Gribble envisioned a new operational infrastructure in which Huntsville Division would offer U.S. based GFP procurement service to the Mediterranean Division. Further in the future, a reorganization of Corps units in the Mediterranean and Middle East was planned to enhance operation of the Saudi Arabian construction program.

Pending the framing of a permanent charter between Mediterranean Division and Huntsville, and interim "Memorandum of Understanding" between Huntsville Division and Saudi Arabia District for "life support" procurement was signed in March 1976. According to this,

> HND was requested and has agreed to support Saudi Arabia District (MDS) in the procurement of furniture and household furnishings for approximately 129 leased villas in Riyadh, Jidda and Dahran. . . Other requirements currently exist and will exist in the future which will require procurement of large dollar value and selected specialty items on an expedited basis in support of MDS. These are requirements over and above normal requirements being processed through Med Div Liaison Det., NY for NYD [New York District] procurement and/or GSA.[2]

Initial procurements during the spring of 1976 were made under this agreement, but it was superceded after 1 July 1976 by a permanent "Memorandum of Understanding Between US Army Engineer Division, Huntsville and US Army Engineer Division, Mediterranean." This document was Huntsville Division's fundamental charter for Saudi Arabian procurement. It states that "USAEDH is responsible for the procurement of GFP equipment and/or supplies and other procurement support. . . as requested by USAEDM, for the support of the Corps of Engineers Saudi Arabia Construction Program." In addition to the usual GFP procurement functions of solicitation, award, claims, and contract closeout, the Division was to develop an automated data processing system for management of the items to be procured. The equipment and materials requirements were to provided as procurement packages complete with specifications, drawings, delivery need dates, and independent cost estimates. Following procurement actions per se and payment of the vendor, Huntsville Division was to be responsible for receipt of items at a continental United States port, packaging, freight forwarding, customs handling, and delivery in Saudi Arabia.[3]

As mentioned above, Huntsville Division's first customer in the Saudi program was the Mediterranean Division's Saudi Arabia District. In June and July 1976, however, the Corps units in the Mediterranean and Middle East were reorganized. The Mediterranean Division was disestablished, and its functions in the Arab nations of Egypt, Jordan, Kuwait, and Saudi Arabia passed to the newly-constituted Middle East Division with its Divisional Headquarters in Riyadh, Saudi Arabia. In turn, the Middle East Division established a Division Forward element in Riyadh for its construction and logistics functions, while a Division Rear element in Winchester, Virginia, maintained the engineering, procurement and supply, and construction project management functions. Corps functions in the Mediterranean basin were transferred to units based in Frankfort, Germany. In practice, these changes meant that after mid-1976 Huntsville Division's Procurement and Supply Division staff extended Saudi GFP contract support directly to the Middle East Division's rear element in Winchester, Virginia, rather than to overseas elements of the Saudi Arabia District as before the reorganization. The "life support" procurement effort covered by the earlier interim agreement with Saudi Arabia District was continued through the spring of 1977, by which time the permanent element in Middle East Division Rear

was staffed to take over this task.

The assumption of the Saudi mission also brought a reorganization within Huntsville Division's Procurement and Supply Division, it being appreciated that the Saudi Arabian GFP mission would soon become its principal activity. In March 1975 the Procurement and Supply Division was still oriented towards the Postal Mission, with two specialized branches out of a total of four devoted to the Bulk Mail Centers procurement. By 30 June 1975, however, the Postal mission was nearing completion. At the direction of the Executive Office, a reorganization of the Procurement and Supply Division produced a Planning and Control Branch, a Contract Services Branch, a Requirements Branch, and a Contracting Branch. When the Saudi Program procurement became the principal mission of the Procurement and Supply Division about a year later, these branches were still in being and formed the organization for handling the mission during 1976. As of August 1976, the staff of the Procurement and Supply Division numbered thirty-five GS employees, including Division Chief Thor S. Anderson and Branch Chiefs Raymond D. Aldridge (Planning and Control), Clyde Mackey (Contract Service), B.G. Scott (Requirements), and T.J. Holt (Contracting).[4]

Until late 1976 much of the service rendered by the Procurement and Supply Division was directed towards "life support" for the Saudi Arabia District and its expanded successor, the Middle East Division. Early in 1976 the Division began receiving Intra-Army Orders for household furniture, appliances, office furniture, printing plant equipment, and a prefabricated warehouse building for Corps quarters and offices. Most of the contracts for these goods were worth less than $200,000 in initial award value; a representative sampling of the list includes:

--DACA87-76-C-0024 for $17,300 to the Tappan Company for gas ranges

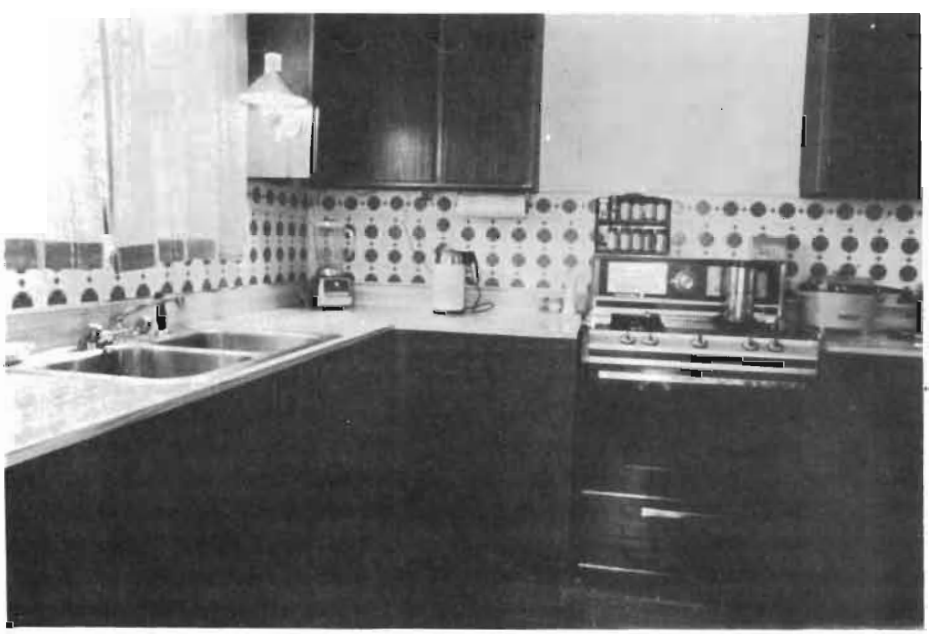
--DACA87-76-C-0027 for $21,921 to the Ivan Allen Company for shelving

--DACA87-76-C-0032 for $151,581 to the Fedders Corporation for air conditioners

--DACA87-76-C-0044 for $43,803 to Kirby Building Systems for a prefabricated warehouse

--DACA87-76-C-0058 for $95,171 to the Goodyear Tire Company for tires[5]

The last of the furniture items for Corps quarters departed Tampa, Florida, on 19 December 1976. It included 1414 wardrobes loaded in eleven containers intended for the ports of Jedda and Dammam. The same ship was also loaded with eighty-two three-bedroom mobile homes and twenty-five office trailers, the delivery on contract DACA87-77-C-0004 awarded to Bendix Home Systems on 21 October for $928,404.00.[6]



CORPS FAMILY HOUSING in Jidda. A typical kitchen.

Procurement for Saudi construction projects also got underway in the first quarter of 1976 with an order for GFP items for the Interim Repair Facility for the Saudi Naval Expansion Program at Dammam. Contracts for industrial plant equipment, related spare parts, and selected construction items totaled about $1 million; by 9 July 1976 75 percent of these items were, or were in process of being delivered. The Interim Repair Facility contracts were virtually complete by mid-October 1976, by which time 90 percent had been, or were in process of being completed.[7]

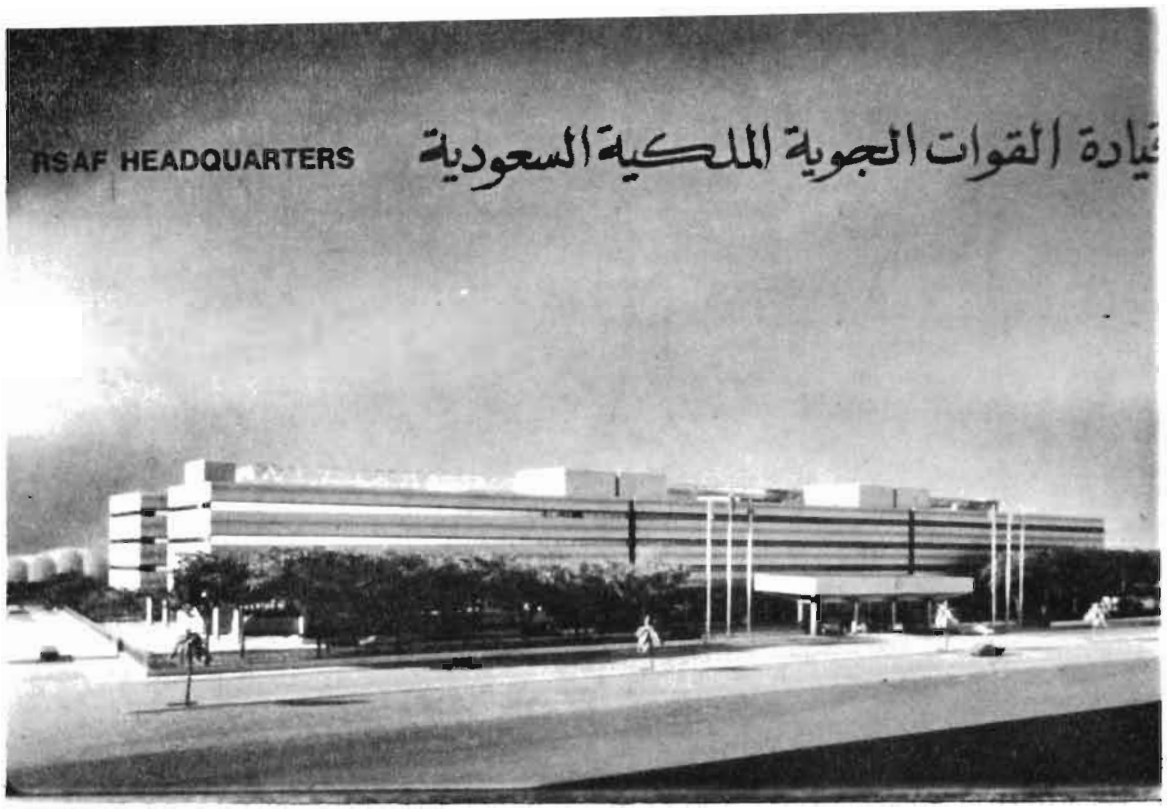
During the last quarter of 1976 the Saudi Program GFP activites began to accelerate with the receipt of large orders destined for the King Khalid Military City project's Concrete Supply System and a dental clinic in Riyadh. Representative of these contracts were two awarded to Mack Trucks, Inc., for $818,919.20 worth of concrete trucks and $423,969.26 worth of other heavy trucks. Dental X-ray equipment was procured for the Riyadh clinic under Contract DACA87-77-C-0005 with GE Dental Systems Operations for $12,451.84.

A ROCK CRUSHER procured by the Huntsville Division for Saudi Construction work.

The overseas shipment of items ranging from dental X-ray equipment to tires in the massive quantities demanded by the Saudi Program was a new experience for the Procurement and Supply Division. The transportation function fell to the Contract Services Branch, which had to research and assemble the requirements in contract solicitation form for receiving, packaging, and shipping supplies and equipment destined for the Middle East. Three channels have been utilized in dispatching Saudi items. Initially arrangements were made with the U.S. Army Packaging Branch in Bayonne, New Jersey, to receive, package, and ship some items. Some forty-one other shipments in 1976 were expedited through State Department Contract 0000-52-0038, a requirements-type contract for packaging, crating, and shipping. Finally, the Division has employed private shipping firms under its own contracts for Saudi shipments. On 31 August 1976 the Procurement and Supply Division awarded the firm of Todd Warehouse and Distributing Company of Bayonne, New Jersey, an unusual requirements-type service contract DACA87-76-C-0054 for packaging, crating, and shipping of Government property. This contract was specifically set up to handle transshipment of goods to Saudi Arabia. Delivery orders are written against the basic contract as required, and the contractor bills Huntsville Divison for individual shipments made.[8]

A permanent comprehensive solution for Saudi logistics was begun by Huntsville Division in mid-1976 when the Middle East Division presented a task for developing a Logistics Management Contract. This contract would consolidate all Corps shipments to Saudi originating out of the Continental United States, provide modular packaging, and packing, arrange surface/air transportation, receive cargo in Saudi Arabia, and provide the management and inventory control for all Corps cargo going to Saudi Arabia. The issuance of a RFP for the Logistics Management Contract was scheduled for 1 November 1976, but shortly before that date the Division learned that pre-qualification of bidders with approval of the Saudi Arabian government would be required. This action delayed issuance of the RFP beyond January 1977.[9]

At Jubal, Saudi Arabia Piers 3 and 4 have a synchrolift.



Royal Saudi Air Force Headquarters (RSAF) as constructed by the Corps.

Tracking of massive procurements such as that for Saudi Arabia was nothing new to the Procurement and Supply Division. The SAFEGUARD and Postal missions had generated considerable experience in the management of vast quantities of material through computer inventorying. In particular, the Bulk Mail Centers program had underlined a valuable "lesson learned": it was a mistake to attempt to adapt computer software developed for an earlier scenario to later and different requirements. Profiting from this experience, an entirely new automatic data processing system for Saudi GFP procurement was launched in conjunction with the ADP Center Branch and the Middle East Division. As it is currently projected, the ADP tracking system will consist of four basic modules: raw data, preaward, awards, and transportation. All systems analysis and programming will be accomplished by the ADP Center in Huntsville Division in conjunction with the Planning and Control Branch.[10]

CHAPTER VII FOOTNOTES

I. In Conjunction With ERDA

[1] See an undated, unsigned, handwritten "Chronology of Events" concerning USAEDH in the ERDA mission. ERDA Liaison Office, CBFDP Working File.

[2]See the "Chronology of Events" in ERDA Liaison Office, CBFDP Working File.

[3]Personal interview with George Barter and Leo Carden, Project Management Branch, USAEDH-ED, 1 March 1977. In the course of this interview, these individuals provided very helpful information about the general course and evolution of Huntsville Division's association with ERDA. I am also indebted to Phil Bradley, ERDA Liaison Officer at USAEDH, for opening his files to me.

[4]Ltr, Sec of Int Rogers C. Morton to Sec of Def James R. Schlesinger, 30 May 1974, sub: Assumption of OCR Mission by CE. ERDA Liaison Office, CBFDP Working File.

[5]Ltr, Dpty Sec of Def William Clements to Sec of Int Rogers B. Morton, 18 Jun 74, sub: Approval of CE Assistance to OCR. ERDA Liaison Office, CBFDP Working File.

[6]"HND Funding Requirements for OCR CBFDP Program," three tabular sheets included with ltr, B.L. Trawicky, Chf USAEDH-ED to HQ Dept Army, 13 Aug 74, sub: Manpower and Funding Requirements OCR CBFDP. ERDA Liaison Office, CBFDP Working File.

[7]"Memorandum of Understanding between Fossil Energy, United States Energy Research and Development Administration, and Office of the Chief of Engineers, Department of the Army, for Providing Technical Service," signed by Maj Gen George A. Rebh, Director of Mil Contr, OCE, on 18 Mar 75, and by Robert Seamans, Jr., Administrator for ERDA, on 12 Jun 75. Copy in ERDA Liaison Office, CBFDP Working File.

[8]Personal interview with Leo Carden, Project Management Branch, USAEDH-ED, 1 March 1977. The figures are for the successful Coalcon response to the RFP.

[9]Personal interview with Leo Carden, Project Management Branch, USAEDH-ED, 1 March 1977.

10 Ltr, Acting Director OCR to Maj Gen George A. Rebh, OCE, 23 Aug 74, sub: Request for Delegation of Manpower from USAEDH for OCR CBFDP Source Selection Board. Copy in ERDA Liaison Office, CBFDP Working File. Further information on the Source Selection Board was provided by William Major, Project Management Branch, USAEDH-ED, who attended Board activities for the RFP CDFDP.

[11]Text of "Fossil Energy Demonstration Plants Briefing" to accompany slide presentation prepared by USAEDH-PAO, 1975; Personal interview with Leo Carden. Project Management Branch, USAEDH-ED, 1 March 1977.

[12]Ltr, F.B. McNeely, Chf Constr Div OCE, to Div Engr USAEDH, 13 Jan 75, sub: CBFDP Procurement Task One. ERDA Liaison Office, CBFDP Working File.

[13]Amendment 2 to ERDA/OCE Memo of Understanding, 12 Jun 75, signed by Maj Gen Bates C. Burnell, Director of Mil Contr, OCE, on 19 Feb 76. ERDA Liaison Office, CBFDP Working File.

[14]Data on the ERDA Pipeline Gas Demonstration Plant proposals was provided by Phil Bradley, ERDA Liaison Officer, USAEDH, through personal interviews during July 1978.

[15]Data on the ERDA Fuel Gas Demonstration Plant proposal activities was provided by Russell C. Hellier, Project Management Branch, USAEDH-ED, through personal interview on 13 July 1978.

[16]Personal interview with William Major, Project Management Branch, USAEDH-ED, 14 July 1978.

II. The Jordanian Armor Rebuild Facility

[1]The principal sources for this section are copies of documents in the project working file maintained by Henry O. Everitt, Project Manager for the Jordanian Armor Rebuild Facility. This file was supplemented for the early period 1974-1975 by additional primary documents supplied by Tom Koonce, Directorate of Military Construction, OCE. The reader is advised that certain production figures for the Armor Center and other material were deleted as "senitive to the Jordanian Government" by action of the Engineering Division staff, USAEDH. Additionally, the author has been informed that certain ASPR provisions prevent the revelation of other AE firms submitted to the Jordanian Government for design of the Center.

[2]Personal interview with Henry O. Everitt, Project Management Branch, USAEDH-ED, April 1977.

[3]Personal interview with Henry O. Everitt, Project Management Branch, USAEDH-ED, April 1977. Msg, USADAO/Amman, Jordan to Sec of Def, 23 Dec 72, sub: JAA GHQ Construction. Copy supplied to the author by Tom Koonce, Directorate of Military Construction, OCE.

[4]Msg, MAP/Amman, Jordan to Dept Army, 6 Jan 75, sub: Jordan Tank Rebuild Facility. Msg, Cmdr AMC to Dept Army, 8 Jan 75, sub: Jordan Tank Rebuild Facility. Msg, MAP/Amman, Jordan to Div Engr USAEDM, Leghorn, Italy, 29 Jan 75, sub: Jordan Tank Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File.

[5]Trip rpt filed by Lt Col Robert A. Dey, MDD-PD on visit to Amman, Jordan, 22-24 Mar 75, dated 27 Mar 75. USAEDH-ED, PM Jordanian Armor Center Working File.

[6]"Technical Agreement Concerning Assistance by the United States Army Corps of Engineers in Designing and Constructing an Armor Rebuild Facility for the Government of Jordan," signed by Maj Gen D.A. Raymond, Dpty Chf of Engrs, 30 Apr 75, and by Lt Gen Sharif Zeid ben Shaker, Chf of Gen Staff, JAF, 25 Apr 75. Copy in USAEDH-ED, PM Jordanian Armor Center Working File. The formal commitment of $500,000 for defined CE services rendered is contained in the U.S. DOD letter of offer signed by Maj Gen Abdul-Haddie al-Majali, Assist Chf Staff, JAF, on 24 Apr 75. A copy supplied to the author by Tom Koonce, Military Construction Directorate, OCE.

[7]Msg, Div Engr USAEDM, Leghorn, Italy to Div Engr USAEDH, 15 May 75, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File.

[8]Msg, Div Engr USAEDM, Leghorn, Italy to Div Engr USAEDH, 15 May 75, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File.

[9]Msg, Div Engr USAEDH to Div Engr USAEDM, Leghorn, Italy, 16 May 75, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File.

[10]Msg, OCE to Div Engr USAEDH, 30 Jul 75, sub: Approval of A-E Selection for Design of Tracked Vehicle Rehab Facility for Jordan Armed Forces. Msg, Div Engr USAEDM, Leghorn, Italy, to MAP/Amman, Jordan, 11 Aug 75, sub: Jordan Armor Rebuild Facility, USAEDH-ED, PM Jordanian Armor Center Working File.

[11]Msg, MAP/Amman, Jordan to Div Engr USAEDM, Leghorn, Italy, 13 Aug 75, sub: Jordan Armor Rebuild Facility. Mst, Div Engr USAEDM, Leghorn, Italy to Div Engr USAEDH, 10 Sep 75, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File

[12]Contract record for Contract DACA87-76-C-0004 in Contract Records File, AE Contract Section, USAEDH-ED.

[13]Msg, Div Engr USAEDH to MAP/Amman, Jordan and to Div Engr USAEDM, Leghorn, Italy, 23 Jan 76, sub: Jordan Armor Facility.

[14]Annex "C" to U.S./Jordanian "Technical Agreement" of 30 Apr 75, "Points of Understanding Resulting from 24-26 February 1976 Review at Giffels Associates, Inc., Office, Detroit, Michigan," attached to ltr, William L. Little, Acting Chf USAEDH-ED, to Div Engr USAEDM, Leghorn, Italy, 18 Mar 75, sub: Report of JMC Review of Giffels Initial Design Jordanian Armor Center. USAEDH-ED, PM Jordanian Armor Center Working File.

[15]See, for example, the msg, Div Engr USAEDM, Leghorn, Italy to Dept Army, 12 Mar 76, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File.

[16]Msg, Div Engr USAEDM, Leghorn, Italy to MAP/Amman, Jordan, 9 Jul 76, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File.

[17]This is the opinion of Henry O. Everitt, USAEDH Project Manager for the Armor Center, expressed to the author in a personal interview in April 1977. It is wholly supported by the continued activities of USAEDH and USAEDM during June 1976 in preparation of AE final design cost structures.

[18]Msg, Div Engr USAEDH to MAP/Amman, Jordan, 25 Jun 76, sub: Jordan Armor Rebuild Depot. USAEDH-ED, PM Jordanian Armor Center Working File.

[19]Msg, MAP/Amman, Jordan to Dept Army, 6 Jul 76, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File. According to the unclassified documents to the author, there was no prior indication of the volte-face at the beginning of July 1976. This is also the belief of Henry O. Everitt, Project Manager, USAEDH-ED.

[20]Msg, Div Engr USAEDH to Div Engr USAEDM, Leghorn, Italy, 12 July 76, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File.

[21]Annex "E" to U.S./Jordanian "Technical Agreement" of 30 Apr 75, "Points of Understanding Resulting from 13 August Meeting in Washington, DC, at the Office of the Chief of Engineers," forwarded by W.L. Little, Chf USAEDH-ED, to U.S. Army Attache, USDAO, Amman, Jordan, on 19 Aug 76. USAEDH-ED, PM Jordanian Armor Center Working File.

[22]Msg, Div Engr USAEDH to USDAO, Amman, Jordan, 17 Sep 76, sub: Jordan Armor Rebuild - Annex E to Tech Agreement. USAEDH—ED, PM Jordanian Armor Center Working File. Contract record for Contract DACA87-76-C-0004 in Contract Records file, AE Contracts Section, USAEDH-ED.

[23]Msg, MAP/Amman, Jordan to Sec of Def, Washington, DC, 28 Sep 76, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File.

[24]Msg, MAP/Amman, Jordan to Sec of Def, Washington, DC, 3 Nov 76, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File. Estimates of costs as of October supplied by Henry O. Everitt in personal interview, April 1977.

[25]Msg, Div Engr USAEDH to USDAO, Amman, Jordan, 16 Dec 76, sub: Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File.

[26]Annex "F" to U.S./Jordanian "Technical Agreement" of 30 Apr 75, "Points of Understanding Resulting from 8 - 9 December Meeting in Detroit at the Office of Giffels Associates, Inc.," attached to ltr, Lt Col Robert W. Senn, Chf, Army Section, MAP/Amman, Jordan to Div Engr USAEDH, 25 Jan 77, sub: Annex F to Technical Agreement for Jordan Armor Rebuild Facility. USAEDH-ED, PM Jordanian Armor Center Working File.

III. The Saudi Arabian GFP Mission

[1]For the background to the contemporary Corps of Engineers presence in the Kingdom of Saudi Arabia, see "Saudi Assignment Appreciated Abroard More Than at Home," **Engineering News Report,** 17 February 1977, pp. 28-38.

[2]"Memo of Understanding" between USAEDH and Saudi Arabia District, USAEDM, 10 Mar 76, sub: "Interim Working Agreement to Provide Procurement Support by Huntsville Division for Saudi Arabia District."

[3]"Memorandum of Understanding Between US Army Engineer Division, Huntsville and US Army Engineer Division, Mediterranean," signed by Col John V. Parish, div Engr USAEDH, on 6 May 76 and Col Charles T. Williams, Div Engr USAEDM, on 9 June 76. Copy provided by Raymond Aldridge, Planning and Control Branch, USAEDH-PS.

[4]See USAEDH-PAO, "Historical Summary FY 1975," II, Documents, pp. 6-25, and USAEDH Table of Distribution and Allowances for August 1976. The TDA for August 1976 was provided by George G. Stewart, Public Affairs Office, USAEDH.

[5]See contract data for 1975 and 1976 provided in USAEDH-PS raw input data for "Historical Summary FY 1976" in USAEDH-PAO "Historical Summary" file.

[6]Ltr, Div Engr Col John V. Parish, Jr., to Lt Gen J.W. Morris, Chf of Engrs, 4 Jan 1977, sub: Quarterly Report USAEDH. Contract Data for 1976 in USAEDH-PS raw input data for "Historical Summary FY 1977" in USAEDH—PAO "Historial Summary" file.

[7]Ltr, Div Engr Col John V. Parish, Jr., to Lt Gen J.W. Morris, Chf of Engrs, 18 Oct 76, sub: Quarterly Report USAEDH.

[8]USAEDH-PS raw input data for "Historial Summary FY 1976" and "Historical Summary FY 1977" in USAEDH—PAO "Historical Summary" file.

[9]Personal interview with Raymond D. Aldridge, Planning and Control Branch, USAEDH-PS, July 1978.

[10]Personal interview with Thor S. Anderson, Chief, USAEDH-PS, July 1978.

CHAPTER VIII

IN RETROSPECT

At the opening of this **History** with the creation of Huntsville Division for the SENTINEL mission in 1967, the observation was made that the unit was a unique formation born out of unprecedented need in the deployment of a nationwide BMD system. No other Corps division had been mobilized for a single task; no other division had its wide geographic responsibility; no other division had to plan, execute, and manage a procurement like the GFP program for the BMD mission. Though the Division is now nine years old and the BMD mission had largely come and gone, the organization retain its legacy of uniqueness within the Corps of Engineers. Several post-BMD missions have underscored the fact that the Divison's record of achievement in specialized engineering and procurement tasks has made it a valuable asset to the Corps, the Army, and the nation.

As this **History** has recounted, the Division was specifically chartered to engineer and construct facilities for the nation's first and only BMD deployment. Although two years have now passed since completion, deactivation, and dismantling of the Grand Forks sites and five years have elapsed since the SALT I Treaty effectively terminated BMD deployment, a definitve judgment about the performance of the facilities must remain speculative. The criteria for the buildings are still confidential for security reasons, and because of this secrecy, it is presently impossible for the layman to accurately assess just how successfully the criteria delineated by SAFSCOM were met. In any case, the abandonment of deployment in the wake of the ABM Treaty makes the question largely academic in 1977.

What can be said with certainty is that as a military engineering mission, SENTINEL (and later, SAFEGUARD) qualifies as one of the most demanding feats in the history of the U.S. Army. It is the belief of this author that leaving questions of its wisdom or worth aside, it will eventually be judged one of the boldest engineering endeavors of all time. In stringency of design parameters, the BMD system should be put into the same category as the MANHATTAN Project or the space program that culminated in the 1969 Apollo XI moon landing. The starkly simple geometric forms that now rise above the wheat fields of North Dakota belie the solution of not one or two but many complex, often conflicting, engineering requirements for hardening and habitability under the most extreme conditions of nuclear holocaust. That the design was done at all is impressive; it becomes little short of amazing when the high pressures of scheduling and funding prevailing in 1968 and 1969 are considered. The same might be said of the contracting and construction under the largest single contract awarded up to that time by the Corps of Engineers. Though there will never be any testimonial inscriptions emplaced there, the Grand Forks SAFEGUARD buildings stand as their own silent witness to American ingenuity in general and the engineering and constructional ability of the Corps and its contractors in particular.

As has been seen, the Army's BMD program was first the victim of public controversy, then of arms limitation talks which cut short the deployment and ultimately abolished it altogether. Before this transpired, however, another singular factor materialized out of the BMD program. This was the decision for maximum standardization among and between facilities, and the subsequent procurement of large quantities of standard items through GFP procedures. From FY 1969 through FY 1974 the Division awarded 130 contracts for tactical support equipment, support of the SAFEGUARD Central Training Facility, and for repair parts and consumable items. These contracts totalled approximately $62.5 million; the total would have been many times greater had the program not been prematurely terminated. Without speculating on the exact amount that might have been saved, it can be said that the SAFEGUARD experience demonstrated the workability of the GFP concept, would have resulted in some cost reductions, and would have permitted the deployment to continue smoothly on its tight schedule. For these reasons, the SAFEGUARD GFP procurement was historic to the Corps; it was historic to Huntsville Division because it created the team expertise that later brought the assignment of Postal and Saudi Arabian GFP procurement missions.

In retrospect, it appears that the most important ingredient in the Division's success in the BMD program was the unusually experienced staff attracted to the SENTINEL program at its inception. Each of the three crucial task areas--engineering, construction, and procurement--was led by highly qualified and seasoned experts who were able to execute the jobs laid before them with exceptional proficiency. Other areas of the Division such as the Office of Counsel also benefited from the experience of the men attracted to them. One notable result of this highly qualified staff was that the Division was able to begin functioning on its mission assignment almost immediately after mobilization and was able to become administratively

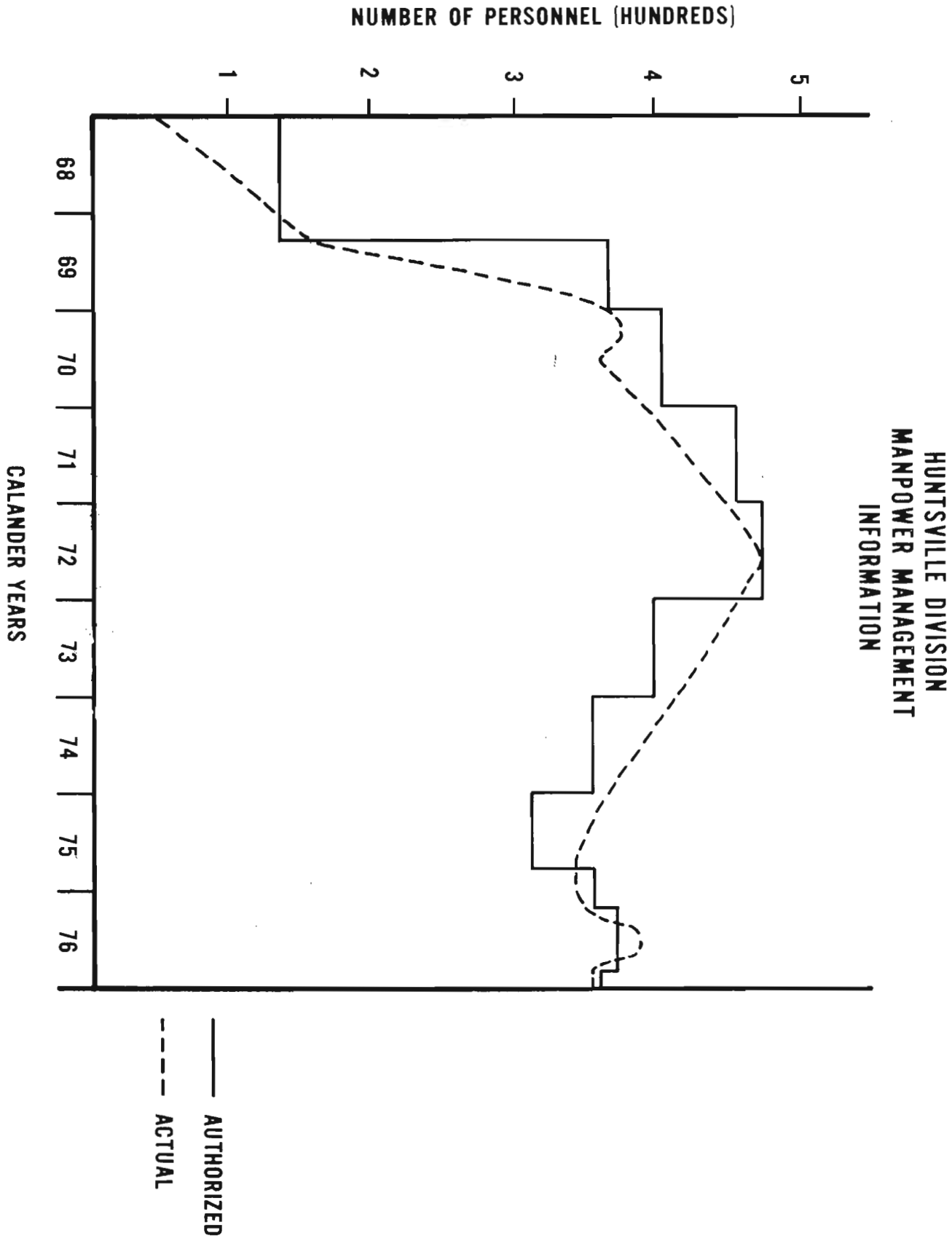
independent with in six months, despite the turmoil of starting up, a transfer to Huntsville, and explosive growth in personnel. Conversely, it is a matter of great importance for the Division's future to recruit new personnel that will sustain the expert community assembled early in the SENTINEL era.

None of the missions following SAFEGUARD have been as spectacular as the high-priority BMD program, and none has left tangible monuments comparable to the SAFEGUARD buildings. Instead, the evidence of Huntsville Division's role in these missions is more subtle and less susceptible to historical evaluation. In the Postal mission, for example, the Division's participation revolved about the preparation and administration of GFP contracts. Perhaps the best testament to Huntsville Division in this mission was a savings to the USPS of about $35 million out of initial estimates of $200 million needed for the Bulk Mail Center equipment. In the Postal mission, as with SAFEGUARD, the Division's successful GFP program did much to ensure that the buildings were completed on time, enabling the USPS to maximize economies arising from new facilities.

A valid historical judgment on Huntsville's four most recent assignments is virtually impossible since none of these missions is complete. Some brief comments, however, on two missions may be in order. The Division entered the MPBSCP at a time when that program was experiencing travail from its complexity and ambitious scope. After introducing three years of central supervision by Huntsville Division and other corrective measures, it may be said that the MPBSCP is progressing satisfactorily and is on the way to successful completion. The crucial milestone reporting system maintained by the Division is now operational, enabling the MPBME Project Manager, DARCOM, and the Department of the Army to make more certain decisions about project priorities and to extract maximum returns from funding for the dozens of existing or anticipated projects. Only the Division's next historian, however, will have the long-range perspective to analyze the savings resulting from improved central management. To fully assess the role of Huntsville Division in the MPBSCP, he will also have to examine the evolution, application, and efficacy of suppressive shielding, pollution abatement, seismic disturbance protection, and other facilities technology currently being developed or considered for the program.

During the next several decades of American history, the Saudi Arabian GFP support mission may well become Huntsville Division's largest mission to date, both in dollar value and in terms of influence on the national course. The Kingdom of Saudi Arabia presently occupies an unusually sensitive place in world affairs, and American influence there may prove to be a decisive factor in preserving the West's petroleum supply as well as encouraging peace and stability in a major world trouble spot. Scarcely ever has the Corps of Engineers had a greater or more crucial opportunity to represent the United States than in this desert kingdom. In retrospect, it is an ironic but sanguine train of events that in nine years has led Huntsville Division from building BMD systems to nation-building through the offering of American know how and goods, also in the interests of peace and the betterment of human conditions.

APPENDIX I


NUMBER OF PERSONNEL (HUNDREDS)
1
2
3
4
5
68
69
70
71
72
73
74
75
76
CALANDER YEARS
HUNTSVILLE DIVISION
MANPOWER MANAGEMENT
INFORMATION
AUTHORIZED
ACTUAL

BIBLIOGRAPHY

The sources used in the preparation of this essay naturally represent only a small fraction of those bearing on the subjects therein. The Huntsville Division has been in existence a scant ten years, and this fact presents the would-be historian with both a blessing and a curse. The author has found that unlike most other conventional history projects, almost every document bearing on the Division's history could be had in original or copy form. This survival even includes the most miniscule detail of contract records, many of which had been retired to the Redstone Arsenal Record Holding Area (RHA) but few of which had been destroyed. It was theoretically possible, therefore, for the author to examine the life history of virtually any contract awarded by the Division since its mobilization . Recourse to this level of detail, however, was necessitated for only a few minor points.

The modernity of the Division's foundation has also resulted in accessability to many of the men who made the history recorded on these pages. Working from an office located on Division premises, the author was able to continuously question the Division's staff and to discuss with it the programs described herein. In virtually every case except SENTINEL and SAFEGUARD, the author was able to interview the project managers or engineers responsible for the decisions taken. Unfortunately, by 1977 the march of time had almost elminated the original engineering staff responsible for SENTINEL and SAFEGUARD. These personal interviews have resulted in a rich fund of information made all the richer by reviews, suggestions, and comments on preliminary drafts.

The Division has also made some effort to systematically record its history. Two such efforts have come to light, both of which have been indispensable. The "History of the Office of Counsel" was put together by Roy Denney, Chief of Contracts and Claims, Office of Counsel, during the years 1967 through 1972. During these years, Denney reviewed events and documents and prepared a semi-annual or annual summary running to several dozen pages. The organization was by topical headings, and the whole was thoroughly indexed in the table of contents. In addition to a textual summary, selected documents were chosen for inclusion in separate volumes of exhibits. These exhibits provided a vast body of primary documents, some of which, of course, were duplicated elsewhere but without the convenience of reference to be found with the "History" listings. The ensemble of text and documents were reviewed and approved each year by the Division's General Counsel, Emil Vuch, and a typescript was prepared by Marie McGahee. The focus of the "History of the Office of Counsel" is naturally a legal one, but references may be found there to almost every significant Division activity during the years covered. Unfortunately, the "History" was discontinued after 1973. The future historians of the Division will be the worse for it.

The "History of the Grand Forks Area Office" also represents a treasure of information about the operations of the Grand Forks Area Office from opening in November 1969 to closing in June 1975. In physical form, it is a three-inch thick ring-bound typescript, of which an unknown number of copies exist. Entries were made day-by-day in diary or chronicle form by Miss Jean Bailey, Program Analyst in the Grand Forks Area Office. In the course of a telephone conversation with Miss Bailey early in 1978, the author learned that the "History of the Grand Forks Area Office" was prepared from newspaper clippings, weekly area office reports, and contact with the area office staff. The fundamental value of this collection is the vast quantity of firsthand information therein; much of it is infused with an earthy human interest flavor brought by Miss Bailey's diligent attention to events not directly related to the construction.

The Public Affairs Office has contributed heavily to this essay in the form of its annual "Historical Summaries" and the "Information Bulletin." The "Historical Summary" was an annual publication prepared by the Public Affairs Officer for the years 1968-1975. The "Historical Summary" was discontinued in 1976, but the raw material for 1976 is presently on file in the Public Affairs Office and data from it has also been utilized. Each issue of the "Historical Summary" comprises two volumes, a "Narrative" and a collection of documents exhibits. The narrative volumes take the form of a day-by-day-chronicle of important events with entries between one line and several pages in length. The "Documents" volume represents a more heterogenous collection of excerpts from the "Information Bulletin," copies of important messages or letters, tables of Divisional organization, data charts, and most importantly, a "Contractual Activities" section containing important facts about each contract awarded or modified during the fiscal year.

The Division's "Information Bulletin" is a small, two-to-four-page in-house news sheet prepared at irregular intervals by the Public Affairs Officer since

1968. A great deal of the material in its article has been derived directly from statements and data contributed by Division employees. It is, therefore, a worthwhile souce of newsworthy happenings. Brief vita of Division staff may also be found in earlier issues. The "Command Information Fact Sheet" was a short-lived photographic information sheet issued twelve times during the heyday of SAFEGUARD construction to publicize the doings at Grand Forks and Malmstrom among Division employees. The "HND Liaison Bulletin" was an even more abortive (three issues) effort at communciation among SENTINEL elements during 1968.

In addition to the above sources, the author has benefited greatly from a voluminous collection of news clippings maintained by the Public Affairs Officers during the SENTINEL and SAFEGUARD programs. Of a similar nature is a bulky scrapbook of news clippings maintained by the Boston Area Office during 1967-1969 and forwarded to the Huntsville Division after closure of the office. Each of these collections encompasses articles from newspapers great and small in the regions around Boston and the North Dakota sites. Because of these news clipping collections, the author has not had to have recourse to a systematic newspaper search. The nature of the Division's programs has also obviated the necessity of a wide serials publication search. The BMD programs remain largely in the domain of secrecy to this day, while programs such as the munitions program, ERDA program, and Postal Bulk Mail Centers program have received little, if any, serious exposure in national magazines. Copies of articles found in files or referred to by employees have been examined and cited where desirable.

The reader should observe that all materials utilized for this study are unclassified. The author made no attempt to secure a security clearance knowing that the information obtained thereby would have to remain confidential. In the case of the SENTINEL and SAFEGUARD programs, some details of the facilities or weapon systems are still classified. The unavoidable result had been a certain ambiguity, imprecision, and perhaps even contradiction in places. In general, however, the author also believes that the description presented is the most comprehensive unclassified account of the BMD construction yet published.

I. ARCHIVAL AND FILE MATERIALS

One eight-inch thick scrapbook of newspaper clippings maintained by the Boston SENTINEL Area Office during the period Sept. 1968 through March 1969. Includes national reports on SENTINEL System as a political issue. This scrapbook is now in the possession of the Public Affairs Office, USAEDH. Citations have been made to individual newspapers rather than to the scrapbook.

Four boxes of mounted unbound newspaper clippings dealing with the Grand Forks and Malmstrom SAFEGUARD sites and the SAFEGUARD program as a national issue, 1969 through 1975. Two of the cartons only have Redstone Arsenal Records Holding Area (RHA) designations: RHA 304 1/2 and 305 2/2.

Four boxes of Grand Forks SAFEGUARD contract records:

RHA 1506 1/34 Chris Berg, Inc.
RHA 1511 6/34 Woerfel Corporation and Town Realty
RHA 1520 15/34 Woerfel Corporation and Town Realty
RHA 1401 4/85 Morrison-Knudsen & Associates

One ringbound notebook containing copies of the AE Contracts Records File maintained by R.L. Phillips, AE Contracts Section, USAEDH-ED. This notebook contains complete financial record of amounts and modifications of each AE contract let by the Division, 1967-1976.

Division Engineer File 1501-07, Munitions Production Base. Executive Office, USAEDH.

Public Affairs Office, "Historical Summary FY 1976" and "Historical Summary FY 1977" raw input data files.

USAEDH-Procurement and Supply Division (PS), Post Support Mission File.

ERDA Liaison Office Working File: Clean Boiler Fuel Demonstration Plant (CBFDP), Pipeline Gas Demonostration Plant (PGDP), and Fuel Gas Demonstration Plant (FGDP). ERDA Liaison Office, USAEDH.

NASA Project Descriptions File maintained by William Major, Project Management Branch, USAEDH—ED.

Jordanian Armor Rebuild Facility Working File maintained by Henry O. Everitt, Project Management Branch. USAEDH-ED.

Command Inspection Reports for Huntsville Division:
Command Inspection, U.S. Army Engineer Division, Huntsville, 28-29 May 1969
Command Inspection, U.S. Army Engineer Division, Huntsville, 24-26 February 1971.
Command Inspection, U.S. Army Engineer Division, Huntsville 9-13 July 1972.
Command Inspection, U.S. Army Engineer Division, Huntsville, 16-18 January 1974.
Command Inspection, U.S. Army Engineer Division, Huntsville, 28-30 July 1975.

II. ORAL HISTORY SOURCES

The following individual supplied magnetic recordings for the preparation of this essay:

Col. John Lillibridge (USA, Ret.), Grand Forks SAFEGUARD Area Engineer,provided the author with a ninety minute magnetic recording of his experiences at Grand Forks, North Dakota.

The following individuals were orally interviewed one or more times in the course of preparation:

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Dale King, Network and Analysis Branch, Construction Division, USAEDH.
William L. Little, Chief, Engineering Division, USAEDH.
William Major, Project Management Branch, Engineering Division, USAEDH.
Carl Manley, Project Management Branch, Engineering Division, USAEDH.
Walter Petersen, Chief, Mechanical-Electrical Branch, Engineering Division, USAEDH.
Sam Presson, Project Management Branch, Engineering Division, USAEDH.
R.L. Phillips, Chief, AE Contracts Section, Engineering Division, USAEDH.
James Reynolds, Contract Specialist, Procurement and Supply Division, USAEDH.
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George G. Stewart, Public Affairs Officer, USAEDH.
Emil Vuch, General Counsel, USAEDH, 1967-1976.
Clyde C. Wright, Mechanical-Electrical Branch, Engineering Division, USAEDH.

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ABBREVIATIONS AND ACRONYMS

AAP - Army Ammunition Plant
ABM - AntiBallistic Missile
ABMDA - Advanced Ballistic Missile Defense Agency
ADP - Automatic Data Processing
AE - Architect-Engineer
AFB - Air Force Base
AMC - U.S. Army Materiel Command (Became DARCOM, 1976)
ARADCOM - U.S. Army Air Defense Command
ARMCOM - U.S. Army Armaments Command
BMC - Bulk Mail Center (USPS)
BMD - Ballistic Missile Defense
BMDATC - Ballistict Missile Defense Advanced Technology Center (Huntsville, Ala.)

BMDO - Ballistic Missile Defense Organization (Huntsville, Ala.)
BMDOA - Ballistic Missile Defense Operations Activity (Colorado Springs, Col.)
BMDSCOM - Ballistic Missile Defense System Command (Huntsville, Ala.)
BOD - Beneficial Occupancy Date
BTL - Bell Telephone Laboratories
CAMBL - Continuous Automated Multi-Base Line (for MPBME)
CBU - Cluster Bomb Unit
CE - Corps of Engineers
CENXD - Corps of Engineers NIKE-X Division
CEPSCO - Corps of Engineers Postal Support Construction Office (at OCE, became DPC)
CERL - Corps of Engineers Construction Engineering Research Laboratory
CISC - Construction Industry Stabilization Committee (Nixon Administration)
COCO - Contractor-owned, contractor-operated (AAP)
COR - Contracting Officer's Representative
DARCOM - U.S. Army Development and Readiness Command (formerly AMC)
DCAS - Defense Contract Administration Services
DDM - Design Deficiency Memorandum
DEMOD - Deployment Model (SENTINEL and SAFEGUARD BMD Systems)
DPC - Directorate of Postal Construction (superceded CEPSCO at OCE)
ECI - Engineer Contracting Instructions
EEO - Equal Employment Opportunity
ER - Engineering Regulation
ERDA - Energy Research and Development Administration
FCUSA - Finance Center, U.S. Army (superceded by U.S. Army Finance and Accounting Center, USAFAC)
FEAT - Field Engineeing Assistance Team (at SAFEGUARD Grand Forks, 1970)
FEC - Federal Electric Corporation
FMCS - Federal Mediation and Conciliation Service
GE - General Electric Company
GFP - Government Furnished Property (sometimes found as GFE)
GOGO - Government Owned, Government Operated (AAP)
HMX - High Melting Explosive
HND - Huntsville Division
ICBM - Inter-Continental Ballistic Missile
IFB - Ivitation For Bids
IRBM - Intermediate Range Ballistic Missile
LAP - Load, Assemble, and Pack (AAP)
LH^2 - Liquid Hydrogen
LOX - Liquid Oxygen
MAF - Michoud Assembly Facility (Chalmette, Louisiana)
MAP - U.S. Army Military Assistance Program
MAR - Multifunction Acquisition Radar (NIKE-X System)
MCA - Military Construction Appropriation, Military Constuction Authorization
MIRV - Multiple Independently Targeted Vehicle
M-KA - Morrison-Knudsen & Associates (joint venture contractor, Grand Forks SAFEGUARD)
MPBME - Munitions Production Base Modernization and Expansion
MPBSCP - Munitions Production Base Support Construction Program
MPTA - Main Propulsion Test Article (NASA)
MSCB - Missile Site Control Building (official SAFEGUARD designation for MSR)
MSFC - Marshall Space Flight Center (Huntsville, Ala.)

MSR - Missile Site Radar (SENTINEL and SAFEGUARD System)
MTF - Mississippi Test Facility (NASA, superceded by NSTL)
MTR - Missile Track Radar (NIKE-ZEUS System)
NASA - National Aeronautics and Space Administration
NEMP - Nuclear Electromagnetic Pulse
NSTL - National Space Technology Laboratory (Bay St. Louis, Mississippi, formerly MTF)
OCE - Office of the Chief of Engineers (Washington, DC)
PAA - Procurement of Ammuniton, Army
PAR - Perimeter Acquisition Radar (SENTINEL and SAFEGUARD Systems)
PARB - Perimeter Acquistion Radar Building (SENTINEL and SAFEGUARD Systems)
P&E - Propellant and Explosive (AAP)
PEMA - Procurement of Equipment and Missiles, Army
PEP - Plant Equipment Package (for MPBSCP)
PKS&A - Peter Kiewit Sons' Company & Associates (joint venture contractor, Malmstrom AFB SAFEGUARD)
PMC - Preferential Mail Facility (USPS)
PS&ER - Production Support & Equipment Replacement
RCA - Radio Corporation of America
R&D - Research and Development
RDX - Research Department Explosive
RFI - Radio Frequency Interference
RFP - Request For Proposal
RFTP - Request For Technical Proposal
RLOB - Remote Launch Operations Building (for SAFEGUARD RLS's)
RLS - Remote Launch Site (SENTINEL, SAFEGUARD SPRINT ABM installation)
SAC - Sulfuric Acid Concentrator
SAFCMD - U.S. Army SAFEGUARD Command (Nekoma, North Dakota)
SAFLOG - U.S. Army SAFEGUARD Logistics Command (Huntsville, Ala.)
SAFSCOM - U.S. Army SAFEGUARD System Command (Huntsville, Ala.)
SAFSM - U.S. Army SAFEGUARD System Manager (Huntsville, Ala.)
SAFSO - U.S. Army SAFEGUARD System Organization
SALT - Strategic Arms Limitations Talks
SCAMP - Small Calibre Ammunition Production (for MPBSCP)
SENLOG - U.S. Army SENTINEL System Logistics Command (Huntsville, Ala.)
SENSCOM - U.S. Army SENTINEL System Command (Huntsville, Ala.)
SENSM - U.S. Arym SENTINEL System Manager (Huntsville, Ala.)
SENSO - U.S. Army SENTINEL System Organization
SLBM - Submarine Launched Ballistic Missile
SRB - Solid Rocket Booster (NASA)
SSME - Space Shuttle Main Engine (NASA)
TDY - Temporary Duty
TIC - Target Intercept Computer (NIKE-ZEUS System)
TNT - TriNitroToluene explosive
TTR - Target Track Radar (NIKE-ZEUS System)
USAEDH - U.S. Army Engineer Division, Huntsville
USC - United States Code
USPS - United States Postal Service
V-1, V-2 - **Vergeltungswaffe** ("revenge weapon") -1, -2
WECo - Western Electric Company
WSC - Weapon System Contractor
ZAR - ZEUS Acqusition Radar (NIKE-ZEUS System)


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