21. HISTORY OF ESTIMATING AND NEGOTIATIONS

Support Contracts:

As indicated in Chapter 20, modifications and claims pertaining to Contracts 3599, 3622 and 3624 were generally minor in nature and, except for one claim awaiting appeal, were settled with little difficulty. Negotiations or dealings with Lewis Hopkins Company and H. Halvorson, Inc. were uncomplicated and excellent cooperation was received in all negotiations. Negotiations with Quality Builders were complicated somewhat by a change in the managing ownership of the firm midway through the completion of the contract. After the change was completed, negotiations with the new management were completed rapidly and under favorable circumstances.

Contract 3552:

At the Larson Area, Contract Administration Branch was responsible for interpretation of the contract and for both estimation and negotiation of matters pertaining to changes in the basic plans and specifications. The nature of the project, which embodied the Concept of Concurrency, an entirely new type of construction, and exceptionally short time available for preparation and review of plans and specifications made problems of contract administration unusually difficult. Details of the financial impact on the final cost of construction at Larson will be covered by the following chapter. During initial stages of construction a number of changes were given to the Area by the Air Force. By working on a full-time basis, the Contract Administration Branch was able to remain abreast of operations. At time of takeover of the Area Office by CEBMCO 71 changes had been made in the original contract.

After the CEBMCO takeover the strength of the personnel of the Contract Administration Branch was augmented by new personnel. The average strength of the Branch in 1961 and through April 1962 was 12, including 9 Estimator-Negotiators. Assistance in alleviating specific problems was given by utilization of Area field personnel temporarily assigned to Contract Administration Branch for the consideration of special problems peculiar to the speciality of the individual. Engineer Districts and CEBMCO furnished personnel on temporary duty as required and a service contract negotiated by the Titan I Directorate furnished from 1 to 5 Estimator-Negotiators from the firm of Estimators, Ltd. Personnel of Estimators, Ltd. proved to be of varying value. Those who were not familiar with Corps estimating and negotiating procedures and who were slow adopting Corps methods were released after a brief trial. The more effective contract employees were retained as required.

As a result of reorganization of the Area under CEBMCO, a Legal Counsel was assigned to duty with the Area. Establishment of the Office of Area Counsel proved to be a great asset in permitting on-the-spot evaluation of the legal aspects of change orders, claims and points of controversy in interpretation of the contract.

Due to the large number of changes necessary a close liaison with the SATAF Commander was required to assure proper implementation of only such changes as the Using and Design Agencies considered essential to the effective use of the weapons system. As a result, each change recommended by the Corps, by the Martin Company and or Associate Contractors, by the Design Agency or by the Using Agency, was considered in a change order conference at which representatives of the Corps' Engineering and Construction Sections worked with SATAF and DMJM representatives to screen and clarify changes in order to permit easier handling and elimination of nonessential items.

The Area Engineer found it necessary during the period of maximum construction effort to keep constant pressure on the prime contractor to assure prompt negotiations on changes and early submittal of claims. In the latter part of 1961 the Area Engineer and the Director, Titan I concluded that presentations by the Contractor were not keeping pace with the progress of construction. Therefore, at a meeting of representatives of the Joint Venturers, Morrison-Knudsen Company agreed to augment the Contract Administration Section of the Contractor's organization. A vice president of Morrison-Knudsen and the firm's Counsel personally entered negotiations on change orders and claims. The Morrison-Knudsen Company's Counsel spent the great majority of his time working with the Larson Area to expedite negotiations and to reorganize submittals for consideration. A large portion of materials considered during these negotiations pertained to work which had been performed by subcontractors and supply contractors.

The Director, Titan I, visited Larson Area frequently and gave personal attention to major contract administration problems. He personally took part in negotiations conducted at the Area Office and held hearings in Los Angeles, San Francisco, and Seattle on changes in excess of the Area Engineer's authority.

Two-Part Modifications:

In view of the large scope of the project and of the unusually large number of changes necessary during construction, the Contractor claimed that an abnormal financial burden was being placed upon him because of the necessity to perform additional or modified construction without being able to receive reimbursement until change orders had been finalized into modifications. To assist the Contractor and his subcontractors, a great portion of the larger change orders were handled as two-part modifications

and as much money as possible was released to the Contractor during or upon completion of the work. The final settlement on such two-part modifications was made after completion of regular negotiations.

Summary:

Titan I Missile Base Construction is by no means a normal construction project. In addition, the urgent requirements of national defense require especially tight construction schedules and the Concept of Concurrency added considerably to the complexity of the problem. As a result of aggressive action by the Area, Titan I Directorate, and by supporting Districts, only 1 modification and 10 claims remained outstanding as of 1 May 1962.

22. REASONS FOR INCREASED COSTS

Contract No. ENG-3599:

This contract increased from an original amount of $172,517.00 to a final amount of $174,788.27. Of the $2,271.27 or 1.32% increase, $1500.45 was attributable to overruns.

Contract No. ENG-3622:

This contract increased from an original amount of $377,638.00 to a final amount of $388,675.00. The $11,037.00 increase is approximately 2.92% of the original contract amount. Modifications amounting to $1,386 were issued as a result of change order conferences pertaining to items of a minor nature. The remaining $9,651 represents claims submitted by the Contractor concerning additional excavation and backfill, additional perimeter insulation, process piping layout discrepancies and a requirement for additional testing.

Contract No. ENG-3624:

This contract increased from an original amount of $414,200 to a final amount of $529,562.75, not including a denied and appealed claim for $12,090.61. The $115,362.75 increase is approximately 27.5% of the original contract amount. Modifications amounting to $47,428 were issued as the result of field changes and Field Office Change Order conferences. The remaining $67,934.75 represents claims submitted by the Contractor, the largest of which was for re-x-raying weldings in the amount of $20,625. Two claims have been denied, one of which (for $12,090.61) has been appealed to the Engineer Board of Contract Appeals.

Contract No. ENG-3552:

General:

Notice to Proceed was given and acknowledged on 21 November 1959. Final completion dates for the three sites covered in the original contract as

amended by Addendum #4 were 30 January 1962 for Site 1-A, 28 February 1962 for Site 1-B and 31 March 1962 for Site 1-C. Time extensions granted for delays beyond the Contractor's control extended these dates to 16 February 1962, 28 March 1962 and 11 April 1962 for Sites 1-A, 1-B, and 1-C, respectively.

The Larson WS-107 A-2 Technical Facility was the second of five Titan I Projects in the United States, all of which were located in the western portion of the country. Uppermost in the minds of all who were responsible for the ICBM construction work at the Larson Area, was the necessity of meeting the Air Force need dates established in the National Defense Program, regardless of problems encountered during construction. The specifications of the various contracts emphasized the importance of getting each contract, each part of the National preparedness effort, completed on time.

At the pre-bid conference for the Missile Launch Complexes held in Walla Walla, Washington, 6 November 1959, Colonel Paul H. Symbol, District Engineer and Contracting Officer, stated in his opening remarks:

> "Now a word about the completion schedule. I feel that one of the most important features of this job is the completion schedule. I can't emphasize too strongly the fact that you must keep the construction on schedule. This will take extraordinary efforts, as the time for the construction of this facility is extremely tight. Completion dates must be met and you cannot expect extra compensation for doing so."

Essentially, the increase in the current working estimate of costs for the Larson Area Missile Launch Complexes and Support Facilities resulted from the necessity for incorporating into the construction a great number of changes occasioned by the fact that the original design concept was undergoing continuous modification as the result of the Concept of Concurrency and by the fact that the original plans and specifications had many errors and omissions as a result of the extreme haste required in preparation and review

of the contract. Generally, no additional time was permitted for accomplishment of these changes and Contractor costs for labor and materials rose considerably.

Changes resulted in two types of additional cost, which might be termed direct and indirect. Direct costs were those easily discernible and readily estimated. Indirect costs were those resulting from the "impact" or "ripple effect", such as were occasioned by delays, the additional cost of working around the work not changed by the modification, and the additional labor costs involved in maintaining scheduled progress by using additional shifts of marginal workers under less-than-optimum working conditions.

The broad aspect of cost increases for the Missile Launch Complex construction is shown by Exhibit "A".

DESIGN CHANGES

During the advertising period from 19 October 1959 until 18 November 1959, when the bids were opened, eight addenda were issued, the last being dated 14 November 1959. These addenda revised and reissued 300 drawings of the total of 578, revised numerous pages of the specifications, and provided a new Section 91, Measurement and Payment, consisting of 14 pages. These changes demonstrated that although all possible efforts had been expended to produce a final set of bidding documents, perfection was impossible in view of time limitations. While the issuance of such revising addenda undoubtedly indicated increased risks inherent in preparation of a bid, and indirectly increased the cost, the designing agency is to be commended for its efforts in attempting to keep the bidding documents current with the design activities. Field changes and design changes are listed under Exhibits "C" through "F".

Revision to Contract Drawings: Revisions in design continued after the construction contract was awarded on 21 November 1959. This is demonstrated by the fact that many contract drawings had been revised by contract modifications. Some drawings were revised over and over again. By addenda, 19 contract drawings were revised by reference to delete that portion relating to the Gate House and Vehicle Storage Shed, and 7 drawings were deleted in their entirety.

The delay to the overall completion of the job occasioned by these many changes contributed substantially to the difficulty of maintaining schedules and minimizing slippages. Throughout the contract life, revised drawings were issued to reflect the many revisions occasioned. One change order alone required 143 revised drawings to adequately reflect the revisions contained therein. Because of this fact, it was extremely difficult to coordinate the changes with the many drawings that are a part of the contract documents. The Air Force initiated what was known as the "As-Being-Built" drawing to reflect the many changes issued by letter, whereby the contractor was directed to revise certain drawings by reference. This necessitated issuing these "As-Being-Built" drawings to all the drawing holders except the contractor who was required to keep his set of drawings current. Approximately 65 sets of drawings of each change were transmitted to designated recipients. This further added to the administrative burden on the Larson Area. In most instances where there were revised drawings, it can be assumed that the Contractor received the changes some two to three weeks after the date of revision. The number of major changes and spacing of the revisions seriously complicated rescheduling.

STANDARDIZED EQUIPMENT

Of particular interest, due to the unique way it was handled, was the Government-Furnished Equipment (GFE) or Standardized Equipment involved at Larson. This consisted of installed equipment purchased by the Government

under contracts assigned to the Prime Contractor. Larson Area was one of several Areas which utilized this method of obtaining GFE by assigning the supply contracts to the Prime Contractor for administration. This presented many problems, however, and it was concluded that much time and effort could have been saved by administering these contracts at the Area level.

The first problem encountered was that of enforcing the specifications applying to GFE, particularly those specifications pertaining to cleanliness and delay in shipment. The Prime Contractor, in essence, was the contracting officer as far as the supply contractors were concerned, and this complicated issuance of modifications to the supply contracts. The Prime Contractor first had to submit the modification to the Area Office for approval before issuing it to the supply contractor; the supply contractor was then paid by the Prime Contractor who in turn billed the Area Office for the payment plus the administrative costs involved.

Eventually, the Area Office took over the entire task of issuance of modifications using information provided from the Sacramento District, the District which had been designated by Los Angeles Field Office to handle changes in the supply contracts originally awarded by Omaha District. Since the Area could not deal with the supply contractors directly, the problems were compounded by having to go through the Prime Contractor. A particular instance involved LOX Equipment Company, the supply contractor for Cryogenic Vessels. Upon arrival at the sites, eight out of nine cryogenic vessels were found to be contaminated according to contract specifications. This required that the Area Office direct the prime contractor to open the vessels for reinspection under Article 9c of the specifications. This was done and the vessels recleaned. Had the supply contract been administered by the

Area Office, this could be enforced to the satisfaction of all concerned. Under the assignment, the Prime Contractor was required to enforce the requirements with the backing of the Area Office. Difficulties were encountered in this transaction by the lack of direct contact between the Government and the supplier.

Another problem, that of technical representatives, arose regarding the installation and operation of some of the equipment furnished under the standardized equipment contracts. Since only two of the contracts provided for services of technical representatives, modifications had to be issued to the remaining contracts to provide for manufacturers' representatives at the sites during installation and checkout of the equipment.

ACCELERATION

In several instances rescheduling of work planned by Air Force Associate Contractors made it necessary for the Area to require the Contractor to accelerate his operations in order to complete a certain piece of work at a date earlier than originally planned. Everything possible was done by the Corps of Engineers to keep the contractor within the prescribed working hours, but in several instances it was necessary in the best interests of the Government to order acceleration. Of particular interest are the following cases where acceleration was authorized in order to meet Air Force requirements:

a. Change Order No. 251 (Mod. No. 263), Accelerate Missile Silo Door Pour. It was determined necessary to complete the Missile Silo doors at Complexes 1-A, 1-B, and 1-C on or before 25 July, 5 August and 1 October 1961, respectively. Therefore, acceleration was authorized to permit double shifts and Saturday work on forming and placing of reinforcing steel to the extent required to meet the new schedule. After the forming and placing,

the doors were to be raised to the open position and firmly anchored as soon as practicable. Work was accelerated to clear the way for future paving and base course operations required to facilitate the Air Force Associate Contractors' work under the revised schedule. Acceleration cost amounted to approximately $22,000.

b. Change Order 274 (Mod 295), Antenna Silo Corrections. In order to insure compatibility with revised plans for installation of Associate Contractor equipment it was necessary to make numerous changes in the East and West Antenna Silos at each of the three sites, even though they had been constructed in accordance with the contract drawings and specifications. A separate completion date of 15 December 1961 was established which necessitated authorizing acceleration in the amount of $5,000 for Complex 1-A. However, shortly after the Complex 1-A revisions were received by the Government, similar corrections were received regarding Complexes 1-B and 1-C. By letter dated 24 July 1961, SATAF stated that the amount of $5,000 originally allocated for Complex 1-A would also suffice for Complex 1-B. It is estimated that approximately $15,000 was required for acceleration at the three Complexes.

c. Change Order No. 296 (Mod 262), Base Course Around Missile Silos at Site 1-A. To permit access by Associate Contractors at a date earlier than originally scheduled, the Contractor was directed to complete placement of the surface course of stabilized aggregate base material at Complex 1-A around Missile Silo No. 2 by 27 July 1961; around Missile Silo No. 1 by 29 July 1961; and around Missile Silo No. 3 by 5 August 1961. The work did not include the area to be paved. In order to accomplish the work as outlined the Contractor was authorized to accelerate as necessary to complete work by the specified dates. The amount of $4,800 was authorized for acceleration by CEEMCO by Message ENGMA-TA-2-0160.

d. Change Order No. 333 (Mod 258), Acceleration of Air Conditioning Tests. Because the Control Center Air Conditioning tests required sole occupancy for proper performance and because the tests required acceleration to reduce interferences with Associate Contractors' installation schedules and to eliminate stand-down time on the part of the contractors it was determined necessary to authorize acceleration. Complex 1-A was tested during the period 4:30 p.m., 13 October 1961 through 8:00 a.m. 16 October; Complex 1-B was tested during the period 4:30 p.m., 27 October 1961 through 8:00 a.m., 30 October 1961; and Complex 1-C during the period 8:00 a.m., 11 November 1961 through 13 November 1961. The settlement for this change contained $8,073 for acceleration for the performance of these tests.

OTHER DELAYING FACTORS

Each delay to the construction under Contract No. ENG-3552 added to the cost of the work, some to a greater extent than others. Obviously, any delay to pacing items such as excavation, concrete work, and crib erection delayed all follow-on work day for day. Delays to other than pacing items were frequently costly in the impact or ripple effect on other items closely associated with the delayed item. In either case the cost of overcoming delays through accelerated effort with its innate inefficiency was a very appreciable item. Joint occupancy with Air Force Associate Contractors during the period March 1961-March 1962 added considerably to the inefficiency of labor.

SUMMARY

The one item which was most representative of the cost was labor, the common denominator for all trades. In addition to cost, it reflects acceleration and contains the inefficiencies of overtime work. Impact too, was included in the added manhours of labor, though an hour of impact cannot be separately distinguished from any other hour of work. As the

result of the factors noted above, the original contract price of $31,600,722 had risen to an estimated $46,772,904 on 1 May 1962, exclusive of unsettled claims. Although this increase of approximately 48% percent in the original contract price may seem great, it must be realized that many of the structures delivered to the Using Agency were, because of the Concept of Concurrency, entirely different from the original designs.

FIELD CHANGE NO.	DESCRIPTION	AMOUNT
51	Pushbutton Requirement Change, P.T.	972
52	Microswitch Designation, E.P.	885
53	Reroute Cable Trays in E.T.	6,000
54	Install Bronze Markers	20,211
55	Modify Vertical Neoprene Closures, E.T. Walls	9,291
56	Waterproof Joint at E.P, Site 1-C	90
57	Liquid Oxygen Storage Tank Bay Covers	36,339
58	Provide Power to Hot Water Pump, C.C.	1,575
59	Relocate Lighting Panel CCB	912
60	Add Manual Heaters to Sewage Aeration Starter	480
61	Remove Beam Sections & Add Columns	4,482
62	Relocate Alarm Panel, Terminal Board & TV Monitor	4,116
63	Relocate 12" Firewater Riser in M.S.	30,141
64	Anchorage for Removable Panels, Raised Floor C.C.	16,785
65	Combined with C.O. 129	
66	Data Change for Valve FCV-508	181
67	Modify Valve TCV-4, E.T.	3,637
68	Modify Cross Brace to Clear 6" Sump Line	1,703
69	Modify Location of Heat Exchanger in East A.S.	4,068
70	Piping Offset Requirement, M.S.	29,955
71	Additional Welding, M.S. Fuel Piping Crib	7,920
72	Cancelled	
73	Firewater Pump Control Relays	6,687
74	Modify Blast Doors #2,3,4 & 6	3,585

FIELD CHANGE NO.	DESCRIPTION	AMOUNT
75	Notch Platform Support, LOX Storage Tank Bays	1,146
76	Cancelled	
77	Modify Ice Bank Liquid Level Controls	51,335
78	Cable Trays, Penetrations & Conduit Elevations, Equipment Terminal	7,572
79	Modify Power Panels, P-E1 & P-E2, P.H.	1,966
80	Cancels FCO 76	
81	Cancels FCO 72	
82 & 82R1	Solderless lugs on Switchgear	3,753
83	Revise Ductwork, Room 402, E.T.	1,323
84	Apply Rubber Base to Room No. 107, C. C.	927
85	Cancelled	
86	Control Station for FCV-806 & 807, P. T.	19,000
87	Add Penetration Holes in Walls, B.L, #1 & 2	4,305
88	Modify West Light in Communication Cable Vault	762
89	Blast Lock #2 Piping Change	4,800
90	8" Pipe Sleeves through M.S. Abutment	No Cost
91 & 91R1	Supply Air Duct in Missile Silo	10,770
92	Delete Periphery Metal Closure, E.T.	(8,214) Credit
93 & 93R1	M.S. Door Hinge Pedestal Correction	49,980
94	Reroute JSN-528 Line in LO_2 Vent Tunnel	17,564
95	Provide Additional M.S. Door Templates	500
96	Install T.R. Vent & Drain Line, T.J. #10	2,392
97	Relocate Quick Disconnect Coupling, M.S.	3,654
98	Cancelled	
99	Provide Control for PH-LC-5V Valve	2,310

FIELD CHANGE NO.	DESCRIPTION	AMOUNT
100	Interference in LO_2 Crib at Elev. 99' 1"	1,435
101	Weld C.C. Upper Level Hatch Support Angles	1,689
102	Relocate Valve CV-702	4,350
103	P.H. Annunciator Panel (Schedule I)	876
104	LOX Crib Column Revision	9,205
105	Replace Vertical Strut, Junction Box #1500, M.S.	1,431
106	Replace PI-4 Gage with PI-5 Gage, A.S, E.P., L.A, F.F, & P. H.	1,593
107	Relocate 6" Contaminated Waste Line from Elev. 21' 2" to 22' 0", Missile Silo	8,757
108	Cable Rack Installation, Communication Manhole	3,735
109	Pipe Sleeves at each Fuel Tunnel Firewall	Combined w/C.O. 309
110 & 110S1	Revise Raw Water & Fire Protection System	Combined w/C.O. 309
111	Pickling Fuel & Lubricating Oil Pipe Lines for Diesel Engines	Incl w/C.O. 275
112	Cancelled	
113	Door Modification	Combined w/C.O. 309
114 & 114S1	Relocate Structure Spring	6,681
115	Drainage Facilities in P.H. & Exhaust Structure	Combined w/c.o. 309
116	Cancelled	
117	Revise Platform Ladder Anchorage in Air Intake Structure	Combined w/C.O. 309
118	Provide Rattle Space in Missile Silo	Combined w/C.O. 309
119	Miscellaneous Changes	70,047
120	Bolted Anchorage for P.H. Pipe Supports	209,448
121	Compressor starter, Panel Doors & Miscellaneous Changes	81,054
122	Combined with FCO 23	

FIELD CHANGE NO.	DESCRIPTION	AMOUNT
123	Combined with FCO 121	
124	Access Plate, Pipe Support Rack, Alarm Panels and Miscellaneous Changes	35,005
125	Combined with FCO 124	
126	Combined with FCO 124	
127	Valve Top Works Support	36,750
128	Combined with FCO 119	
129	Combined with FCO 121	
130	Revise Closure Seals, P.H. Air Intake Str.	21,107
131	Acceleration of Air Conditioning Tests	10,380
132	Change Anchoring of Hot Water Return Lines in Tunnels	20,680
133	Combined with FCO 131	
134	Combined with FCO 132	
135	Combined with FCO 132	
136	Eliminate Anchor Interference, P.T.	1,150
137	Delete Painting of Insulated Hot Water and Glycol Piping	(7,239) Credit
138	Cancelled	
139	Combined with FCO 131	
140	Drainage Holes Under Tunnel Floors, Site 1-C	27,865
141	Modify E.P. Door Center & Side Seal	15,452
142	Miscellaneous Revisions in P.H. Air Intake Structure	31,870
143	Modify Pressure Selector Relay on Air Conditioning	21,528
144	Revisions to Blast Valves	158,500
145	Cancels FCO 138	

FIELD CHANGE NO.	DESCRIPTION	AMOUNT
146	Delete Placing E.T. Roof Hatch Plugs	(540) Credit
147	Delete Concrete Fill, M.S.	(24,927) Credit
148	Move Fuel Vapor Detector	2,487
149	Delete Ventilating Tests, M.S.	2,619
150	Relocate FCV 806-1 & 807-1 in LO_2 Tunnel, Complex 1-A	3,619
151	Interim Control of Excess Water, Site 1-C	Withdrawn
152	Modify E.P. Instrument Mount	12,025
153	Waterproof Insulation on CH & CHR lines, 1-C	6,198
154	Cancelled	
	Total Field Changes (SATAF)	$1,475,811

EXHIBIT B
CORPS OF ENGINEERS INITIATED FIELD CHANGES
CONTRACT ENG-3552

FIELD CHANGE NO.	DESCRIPTION	AMOUNT
17	Deletion of Rock Bolt Blockouts	No Cost
58	Reversal of P.H. Generator Slab Form, Site 1-A	1,125
62	Overexcavation and Test Pit in C.C. & P.H., Site 1-B	9,294
69	P.H. Air Exhaust Footings, Complexes 1-A & 1-B	2,173
72	Gunite Cover of Air Exhaust Footing, Site 1-B	1,495
76	Cleanliness Inspection Facilities	52,500
111	Antenna Junction Modification	1,008
123	Etching Segments for PLS Cleaning	2,186
127	Administration of Standardized Equipment Mods to 31 December 1960	39,738
148	Change in Waterproofing, M.S., Complexes 1-B and 1-C	No Cost
185	Correction to Reinforcing Steel Placement in M. S. at Complex 1-C	8,132
188	Substitution of Gasket Materials & Flanges on Cryogenic Vessels (Schedule B)	4,710
199	Protective Devices on Valves & Fittings, Cryogenic Vessels (Schedule B)	9,202
211	Substitute Fluorogreen PLS Gaskets	22,669
214	Completion Dates for Access Roads and Finish Site Grading and Roads	No Cost
221	Metal Culvert for Fuel Supply & Nitrogen Filler Lines, T.J. #12	4,590
223	Correction of Distorted Floor & Piping Supports in Tunnel Junction, Complex 1-B	12,343
227	Manual Pump Vault, E.P.	2,100
231	Cut Holes in Fuel Crib Platform Plates	414
269	Cleaning & Preparation of PLS Equipment	139,581
273	Final Leak Check on PLS System	No Cost

FIELD CHANGE NO.	DESCRIPTION	AMOUNT
284	Provide Manufacturers Representatives for Standardized Equipment	107,340
288	Add Blowdown & Position Valves	5,335
289	Pipe Railing Between Accumulator Bank & Elevator Shaft, E.P.	639
296	Base Course Around M.S., Complex 1-A	4,800
340	Modify PLS Regulator PRV-562, RP-1 Fuel System	6,015
341	Furnish Spare Parts for Standardized Equipment	54,066
342	Furnish Spare Parts for Contractor-Furnished Equipment	88,433
	Total Field Changes (CE)	$579,888

EXHIBIT C
AIR FORCE INITIATED DESIGN CHANGES
CONTRACT ENG-3552

DESIGN CHANGE NO.	DESCRIPTION	AMOUNT
1 & 3	Miscellaneous Revisions & Delete Requirements for Post Tensioning Rock Bolts	66,405
2	Change Spring Beams to High Strength Steel	5,930
4	Add Irrigation Culvert & revise Concrete Tractor Crossing from 12' to 50'	6,347
6	Revision of Spare Parts Documentation and Revise Section SC-4	8,500
8	General Revision No. 2	168,200
11	Flexible Hose Revision	125,490
12	Missile Silo Doors	123,315
14	Ground Mat Resistance	3,661
15	Spring Beam Assembly Pins	1,110
16	Deletion of Segregated Storage Magazines	(12,391) Credit
18	Miscellaneous Changes	3,693
21	Delete Appurtenances for Gate House and Vehicle Storage Shed	(32,650) Credit
22	Modification of Water Control Valves	7,983
26	Revisions in Shock Testing Specs	99,000
35	Delete Communications Silo, Complex 1-B	(5,940) Credit
38	Wire Limit Switches for Valves CV-160 & 161	2,517
45	Modify Fuel & PLS Cribs	47,367
51	Allowances for Deflections of Spring Beams	5,802
53	Revise Connection of Tank T-110 and T-510 to Tunnel Junction #12	3,500
65	Miscellaneous Changes	377,764

DESIGN CHANGE NO.	DESCRIPTION	AMOUNT
73	Fuel System Anchors & Details	55,791
74	Evaporation Loss Tests, Tanks T-401 & 402	(14,077)Credit
75	Revision to Fuel Transfer Panels	No Cost
77	Delete Gimbal Joints in PLS Piping	1,080
89	Redesign of PLS Piping	210,000
98	Revised C-2 Compressor Mounting	86,639
101	Structural Changes to LOX Crib	53,550
102	Changes to PLS Piping Tunnel Supports	225,000
108	Modification of Blast Door Hinge	38,586
109	Revised PLS Testing Specifications	1,249,444
112	Bench Testing of Safety Valves	106,068
128	Security Fence Change	27,372
129	Changes to PLS Pipe Supports, LOX Crib, M.S., & P.T.	1,256,500
134	Increase Drying Requirement	6,245
135	Modify Indicator Lights for Fuel Transfer Panel	1,966
137	Polyethylene Covers on Cryogenic Vessel Flanges	391
204	Modification to Excess Flow Valve, Firewater System	99,240
213	Reinforce Blast Locks	169,994
222	Additional Flex Hose Supports	257,790
234	Facility Test Plan	No Cost
242	Relocate M.S. Door Position Switch	155
248	Tunnel Junction #12, PLS Fuel Pipe Supports	89,553
255	Addition of Sealer to Vent Shaft Insulation	14,283

DESIGN CHANGE NO.	DESCRIPTION	AMOUNT
256	Anchor Bolts for Communication Manhole Cover	675
257	Antenna Silo Bracket Support	50,100
270	Portal Silo Hydraulic Cylinder Clevis Reinforcement	2,544
275	Pickling Fuel & Lube Oil Lines for Diesel Engines	199,099
297	Relocate JSN-508 Line	8,637
302	Revisions to Blast Valves	158,500
305	Additions to RP-1 Fuel System	97,984
327	Additional Flex $H_o$ses, Equipment Terminal	200,485
328	Fuel Fill Connection, T.J. #12	12,800
345	Modifications to Portal Door Hydraulic System	62,970
356	Chemical Grouting Tests, Complex 1-C	10,580
366	Modify Firewater Controls	25,800
	Total Design Changes (USAF)	$5,771,347

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EXHIBIT D
CORPS OF ENGINEERS INITIATED DESIGN CHANGES
CONTRACT ENG-3552

DESIGN CHANGE NO.	DESCRIPTION	AMOUNT
126	Revised Cleaning Requirements & Manway Relocation, Cryogenic Vessels	52,806
136	Modification of Controls & Addition of Alternators for the Contaminated Waste Pumps	13,654
150	Various General Provisions	67,078
151	Shock Testing of Equipment	725
152	Additional Panel Changes	750
153	Miscellaneous Changes, Liquid Sensors, Transfer Panels	15,624
158	Bolted Flanges, T-201 Tanks	180
165	Reduction of Engine Shop Test Period	(180) Credit
167	Various General Revisions	291
172	Greater Insulation Protection for Motors	131
178	Shock Testing of Equipment	725
179	Revision to Blast Detector Support System	7,244
182	Various General Revisions	16,040
189	Revised Conduit Layout, A.S.	3,699
247	Substitute Pipe for Pumps During Test E	7,545
	Total for Design Changes (CE)	$186,312