Previous

Clay Pipe Engineering Manual

Chapter 2, Gravity Sewer Design

Part I - Planning and Layout Sewer Planning

Planning for the economical development of a sewer system requires information on current flows and forecasts of future flows. The projection of flow increases should provide sufficient lead time to formulate economic proposals, secure approvals, arrange financing, design, construct and place in operation the necessary sewers to carry domestic, commercial and industrial wastewater from a community to a point of treatment.

Design Period

A design period must be chosen and sewer capacity planned that will be adequate. Professional planners are reluctant to predict land use or population changes for more than 20 years into the future. However, when planning, design, financing and construction are considered together with the relatively minor additional cost of providing extra capacity, a 50 year design period is the minimum that should be considered. Planners should design for ultimate development where special conditions exist such as remote areas near the boundary of a drainage area. Also to be considered are areas where special construction, such as tunnels and siphons, may be required. The cost of additional capacity is minimal compared to the cost of relief lines installed at a later date.

Mainline sewers should be designed for the population density expected in the areas served, since the quantity of domestic sewage is a function of the population and of water consumption. Trunk and interceptor sewers should be designed for the tributary areas, land use and the projected population. For these larger sewers, past and future trends in population, water use and sewage flows must be considered. The life expectancy of the pipe is critical when considering extended design periods.

Drainage Area

A drainage area is the territory being considered within which it is possible to find a continuously downhill surface route from any point to the established outlet. Drainage areas should also include areas that are tributary by gravity that will be served by future sewer construction and areas that are not tributary by gravity which could be served by pumping or adverse grade construction. It should be noted that natural drainage boundaries do not necessarily coincide with political boundaries.

Design Flows

A sanitary sewer has two main functions: (1) to carry the peak discharge for which it is designed, and (2) to transport suspended solids so that deposits in the sewer are kept to a minimum. It is essential, therefore, that the sewer have adequate capacity for the peak flow and that it function properly at minimum flows.

The peak flow determines the hydraulic capacity of sewers, pump stations and treatment plants. Minimum flows must be considered in design of sewers and siphons to insure reasonable cleansing velocities.

Population Estimates

The best tool to use for estimating future sewage flow is population data. Forecasts of commercial and industrial flows are also helpful. A long range population forecast is needed and, if possible, an estimate of future commercial and industrial development. A larger value for gallons/capita/day (gcd) should be used when these estimates are not available.

Population data should be collected for the total drainage area. Population projections for large areas are generally more accurate than for smaller areas because historic records are more readily available and local changes have less influence.

Convert Population Data to Average Flow

Convert population data to quantity of sewage using an average gallons/capita /day (gcd). This per capita flow varies f- n 50 to 140 and some areas as high as 160 where industrial flows are included. The minimum and maximum .age daily quantities for the initial and final years of the design period are necessary for designing siphons and .eatment plants.

A value of 100 gcd has been found to be a reasonable average flow. This does not include commercial and industrial flows. An over-all figure of about 125 gcd may be used to convert population to average flow including commercial and industrial flow. The Land Use Coefficients (page 13) can be used to predict flow from future land use. These coefficients should be adjusted in accordance with flow studies in the local area. These rates make no allowances for flow from foundation drains, roofs or yard drains, none of which should be connected to a sanitary sewer. Plot a projection of average flow for the drainage area. A factor is applied to account for the variation between average flow and peak flow. This variation is primarily the result of the time of concentration since peak flows do not reach a point in a sewer at the same time. The use of a higher factor for small area flows (mainline sewers) as compared to large area flows (trunk sewers) is justified because small flows are particularly sensitive to changes, where a slight increase in rate of flow represents a large percentage increase. Larger areas and larger flows have a greater time of concentration that reduces the resulting variation.

Peak Factors

The "Peak Factor Table" (page 17) may be used to raise average flow to peak flow. "Peak Factors" are the relationship between average daily dry weather flow and the highest dry weather peak of the year and varies from 1.3 to 3.5. This method yields a reasonable estimate of the peak factors. As flows increase, the peak factor decreases. If possible, the peak factors should be adjusted to flow studies in the local area.

Extraneous Flows

.tary sewer design quantities should include consideration of the various non-sewage components which nevitably become a part of the total flow. The cost of transporting, pumping and treating sewage obviously increases as the quantity of flow delivered to the pumps or treatment facility increases. Thus, extraneous flow should be kept within economically justifiable limits by proper design and construction practices and adequately enforced connection regulations.

Inflow

A very few illicit roof drains connected to the sanitary sewer can result in a surcharge of smaller sewers. For example, a rainfall of 1 in. per hour on 1,200 sq. ft. of roof area, would contribute more than 12 gpm.

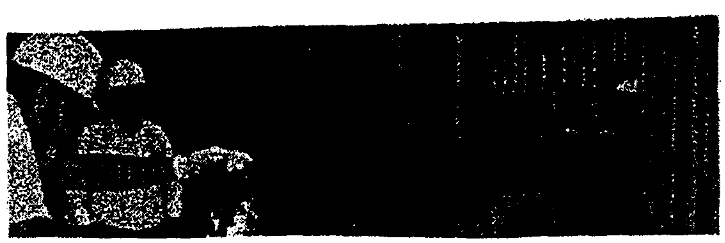
Connection of roof, yard and foundation drains to sanitary sewers should be legally prohibited and steps taken to eliminate them. Water from these sources and surface run off should be directed to a storm drainage system.

Tests indicate that leakage through manhole covers may be from 20 to 70 gpm with a depth of 1 in. of water over the cover. Such leakage may contribute amounts of storm water exceeding the average sanitary flow.

Infiltration

Two very prominent sources of excessive infiltration can be poorly constructed manholes and or connections and improperly laid house laterals. Laterals frequently have a total length greater than the collecting system and may contribute as much as 90% of infiltration. House connections should receive the same specifications, construction and inspection as public sewers.

ie past, sewer designers allowed higher amounts of nfiltration to aid in transporting solids. Infiltration must now be kept to a minimum.



Advantages of Compression Joints and Couplings

ASTM C 425 *Compression Joints for Vitrified Clay Pipe and Fittings* have essentially replaced all other forms of joining vitrified clay pipe. Obsolete field joining systems can be major contributors to infiltration. The advantages of limiting infiltration, exfiltration and roots 'e providing flexibility and durability have been videly demonstrated. A tight and flexible joint is clearly desirable whether the sewer is above or below ground water.

Summations of Flow

Starting at the upper end of the sewer under review, add projected average flows for 50 or more years in the future. As the projected average flows from each drainage area are totaled, multiply by the appropriate peak factor (page 17) to determine the peak flow for each reach of the line. These values are the design capacities for the proposed sewer (page 15).

Flow Monitoring

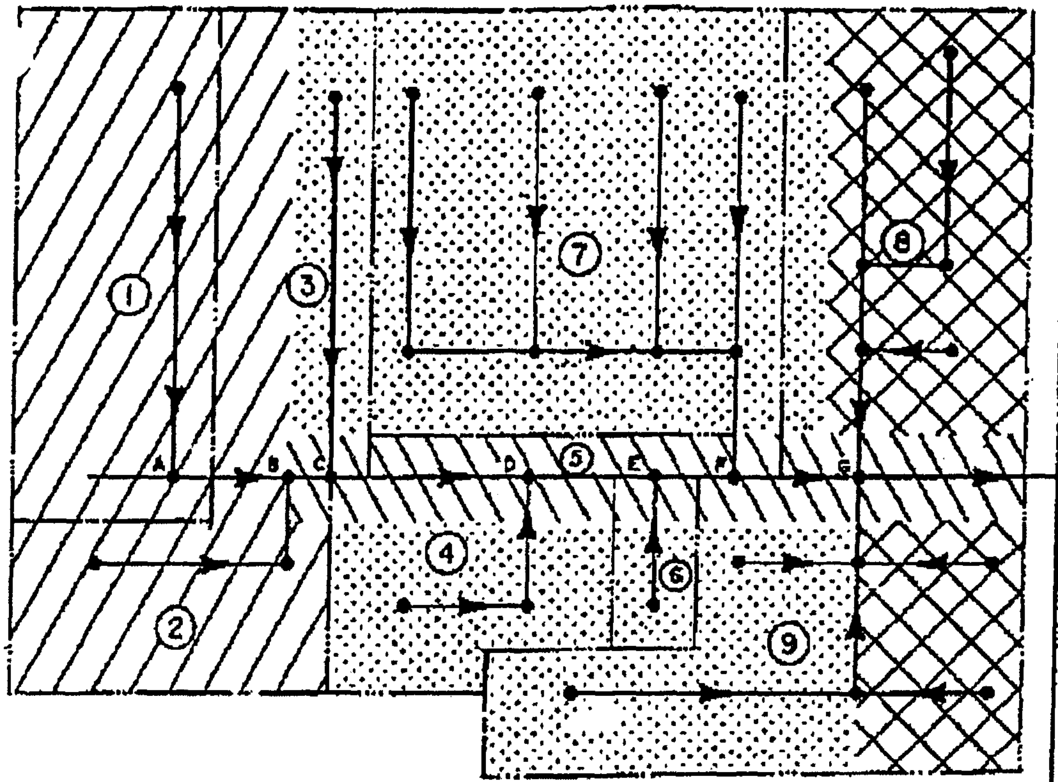
A sewer flow monitoring program is necessary to determine when existing sewers will reach hydraulic design capacity. Monitoring methods vary from high water markers that record maximum depths to gaging with hand held mechanical tools or electronic devices. With a history of flow data, projections can forecast the year the peak flow will reach the design capacity of the sewer.

Check adjacent population, gagings, water consumption, rainfall and any other available data to determine if the measured quantity of flow is reasonable. If adjacent measurements or the estimate is greatly different from the gaged amount, the cause should be identified and corrected before proceeding with a relief sewer. With a long range projection of peak flow based on population and a short range projection based on past gagings, a reasonable estimate utilizing both can be made. As new or more reliable information becomes available, the projection should 'pdated. Planning for relief sewers must begin with sufficient lead time before the projection reaches the design capacity of the sewer.

Sewer line modeling computer programs are available to analyze existing systems and establish quantities for the design of relief sewers.

LAND USE	ABR.	AVERAGE COEFFICIENTS	
High Density R4, R5	H.D.	140 People/Acre (100 gcd)	.0217 cfs/Acre
Medium Density R3	M.D.	75 People/Acre (100 gcd)	.0116 cfs/Acre
Low Density RS, R1, R2	L.D.	20 People/Acre (100 gcd)	.0031 cfs/Acre
Suburban RA, RE	Sub	10 People/Acre (100 gcd)	.0016 cfs/Acre
Hillside	H.S.	7 People/Acre (100 gcd)	.0011 cfs/Acre
Agriculture A1, A2	Agr	2.5 People/Acre (100 gcd)	.0004 cfs/Acre
Light Industry CM, M1, M2	Lt	0.008 cfs/Acre	
Heavy Industry M3	Hvy	0.008 cfs/Acre	
General Commercial 2, 3, 5	Gen	0.008 cfs/Acre	
Limited Commercial CR, 1, 2	Ltd	0.006 cfs/Acre	
Hospital	H	500 gal/day/hosp. bed	
School	S	0.062 cfs/School	
University or College	U	0.371 cfs/Univ.	
Civic or Admin. Center	C.C.	0.006 cfs/Acre	
Airport	A	0.001 cfs/Acre	
Park	P	0.0003 cfs/Acre	
Future Park	F.P.	0.0003 cfs/Acre	
Golf	G	0.0003 cfs/Acre	
Cemetery	C	0	
Reservoir	R	0	
Public Works	W	0	
Open Space	O.S.	0	

SAMPLE LAND USE MAP



MH	A	B	C	D	E	F	G
Qav.	.37	.59	1.21	1.98	2.14	4.47	9.19
Qd.	.96	1.53	2.8	4.5	4.8	9.4	18

LEGEND

- Exist. or Prop. Sewer
- Drainage Area Boundary - Lettered Manhole = Confluence Manhole — Flows generated in each drainage area can be accumulated along the sewer being studied.
- Low Density Res. - L. D.
- Medium Density Res. - M. D.
- High Density Res. - H. D.
- Commercial - Comm.

Future or Ultimate land use information will normally determine the area in acres of each land use within each drainage area.

- Qav. Average Quantity
- Qpk. Peak Quantity
- Qd. Design Quantity = QPK

From flow estimating calculations

SAMPLE OF FLOW ESTIMATING CALCULATIONS

FLOW ESTIMATING CALCULATIONS
(From Land Use Information)

Dr. Area	Land Use	Area	Coef.	Qav.	Pf	QPk	Sum. Qav.	Pf	Qd	Outflow from M.H.
1	LD	120	.0031	.372						

				.37	2.60	.96				
							.37	2.60	.96	A
2	LD	68	.0031	.211						
	COM	2	.006	.012						
				.22	2.80	.6				
							.59	2.60	1.53	B
3	LD	44	.0031	.136						
	MD	40	.0116	.464						
	COM	4	.006	.024						
				.62	2.50	1.6				
							1.21	2.35	2.8	C
4	MD	50	.0116	.580						
	COM	14	.006	.084						
				.66	2.50	1.6				
							1.87			
5	COM	18	.006	.108						
				.11	2.80	.3				
							1.98	2.25	4.5	D
6	MD	12	.0116	.139						
	COM	4	.006	.024						
				.16	2.80	.4				
							2.14	2.25	4.8	E
7	MD	200	.0116	2.320						
	COM	2	.006	.012						
				2.33	2.25	5.2				
							4.47	2.10	9.4	F
8	HD	120	.0217	2.604						
	COM	12	.006	.072						
				2.68	2.20	5.9				
							7.15			
9	MD	78	.0116	.905						
	HD	48	.0217	1.042						
	COM	16	.006	.096						
				2.04	2.25	4.6				
							9.19	1.98	18.0	G

1. The coefficients of discharge used in this example are as follows:

(cfs per acre from page 13)

v Density	LD	.0031
Medium Density	MD	.0116
High Density	HD	.0217
Commercial	Comm	.006

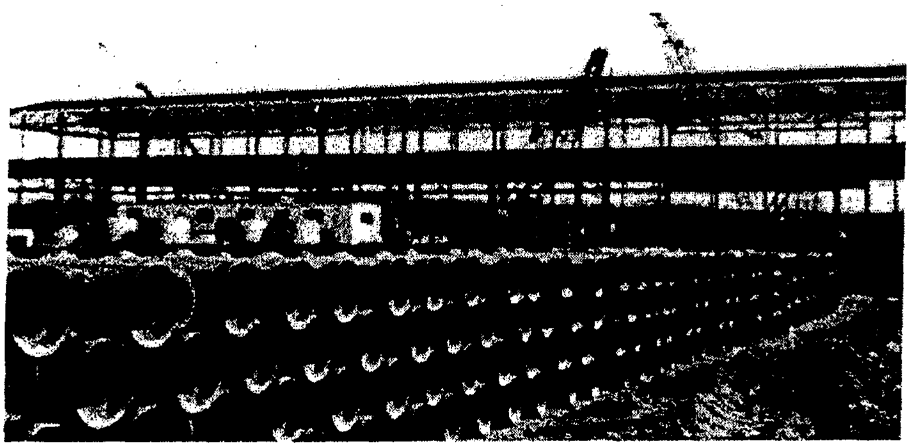
2. Peak Factors (Pf) are shown in the Peak Factor Table (page 17).

3. Qav flows are accumulated as they become tributary to the line. See Sample Land Use Map (page 14) and Sample of Flow Estimating Calculations (page 15). Dr. Area 1 average flow is totaled and converted to Qpk in Manhole (MH) A, Dr. Area 2 is added at MH B, Dr. Area 3 is added at MH C, Dr. Area 4 is added at MH D. Dr. Area 5 is served by a number of house connection sewers directly tributary to the study sewer all along the Drainage Area. To simplify calculations the flow from this area has been lumped together and added at one point. The point arbitrary selected was MH D so Dr. Areas 4 and 5 are both added at that point. As each Qav is added to the sum of upstream Qav's the subtotal is converted to Qpk with the Pf. The Qpk or Qd downstream from MH D in this example is 4.5 cfs.

4. If a larger sewer was being studied, this entire area could be considered one Drainage Area with the same procedures followed to accumulate Qav and then convert to Qpk using the Peak Factors.

5. If a relief sewer was proposed that would intercept a portion of this Study Area the average flow from Drainage Areas or parts of Drainage Areas tributary to the new line would be added to the relief line and subtracted from the existing line. The average flows would be totaled and converted to Peak using Peak Factors.

6 The estimated Qav and Qpk's are shown on the Sample Land Use Map. The Qav's are shown because they can be ıy added and subtracted and are useful when studying alternate routes, etc. The Qpk's are the quantities to be used to determine the adequacy of an existing sewer or to design a new one. These Qpk's can also be called Qd.



PEAK FACTOR TABLE

Qav = Average Flow Pf = Peak Factor Qpk = Peak Flow

Qav	Pf	Qpk	Qav	Pf	Qpk
0 – 0.1	3.50	0 – 0.3	58 – 66	1.62	95 – 106
0.1 – 0.3	2.80	0.3 – 0.8	66 – 78	1.60	106 – 124
0.3 – 0.6	2.60	0.8 – 1.5	78 – 83	1.58	124 – 131
0.6 – 0.9	2.50	1.5 – 2.2	83 – 87	1.57	131 – 136
0.9 – 1.2	2.40	2.2 – 2.8	87 – 95	1.56	136 – 148
1.2 – 1.5	2.35	2.8 – 3.5	95 – 101	1.55	148 – 156
1.5 – 1.9	2.30	3.5 – 4.3	101 – 108	1.54	156 – 166

1.9 - 2.4	2.25	4.3 - 5.3	108 - 116	1.53	166 - 177
2.4 - 3.0	2.20	5.3 - 6.5	116 - 124	1.52	177 - 188
3.0 - 3.8	2.15	6.5 - 8.1	124 - 133	1.51	188 - 200
3.8 - 4.9	2.10	8.1 - 10.2	133 - 142	1.50	200 - 212
4.9 - 6.3	2.05	10.2 - 12.8	142 - 152	1.49	212 - 226
6.3 - 7.5	2.00	12.8 - 14.9	152 - 163	1.48	226 - 240
7.6 - 8.3	1.98	14.9 - 16.4	163 - 175	1.47	240 - 256
8.3 - 9.2	1.96	16.4 - 17.9	175 - 188	1.46	256 - 274
9.2 - 10.3	1.94	17.9 - 19.9	188 - 202	1.45	274 - 292
10.3 - 11.4	1.92	19.9 - 22.0	202 - 216	1.44	292 - 310
11.4 - 12.7	1.90	22.0 - 24.0	216 - 233	1.43	310 - 332
12.7 - 14.2	1.88	24.0 - 27.0	233 - 250	1.42	332 - 354
14.2 - 15.9	1.86	27.0 - 29.0	250 - 269	1.41	354 - 378
15.9 - 18.0	1.84	29.0 - 33.0	269 - 290	1.40	378 - 405
18.0 - 20.0	1.82	33.0 - 36.0	290 - 312	1.39	405 - 432
20.0 - 22.0	1.80	36.0 - 39.0	312 - 336	1.38	432 - 462
22.0 - 25.0	1.78	39.0 - 44.0	336 - 362	1.37	462 - 494
25.0 - 28.0	1.76	44.0 - 49.0	362 - 391	1.36	494 - 530
28.0 - 32.0	1.74	49.0 - 55.0	391 - 422	1.35	530 - 568
32.0 - 36.0	1.72	55.0 - 62.0	422 - 455	1.34	568 - 607
36.0 - 40.0	1.70	62.0 - 68.0	455 - 492	1.33	607 - 652
40.0 - 45.0	1.68	68.0 - 75.0	492 - 532	1.32	652 - 700
45.0 - 51.0	1.66	75.0 - 84.0	532 - 575	1.31	700 - 750
51.0 - 58.0	1.64	84.0 - 95.0	575 - ∞	1.30	750 - ∞

GRAVITY SEWER DESIGN

Part II - Hydraulic Design

Basic Premises for Calculating Flow in Sewers

This section on hydraulics of sewers deals only with uniform flow. Standard hydraulic handbooks should be consulted for special conditions.

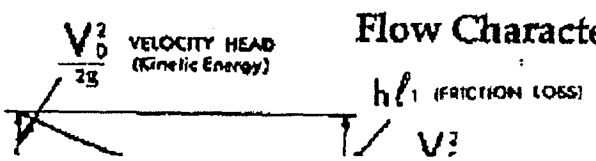
Since the flow characteristics of sewage and water are similar, the surface of the sewage will seek to level itself when introduced into a channel with a sloping invert. This physical phenomenon induces movement known as gravity flow. Most sewers are of this type.

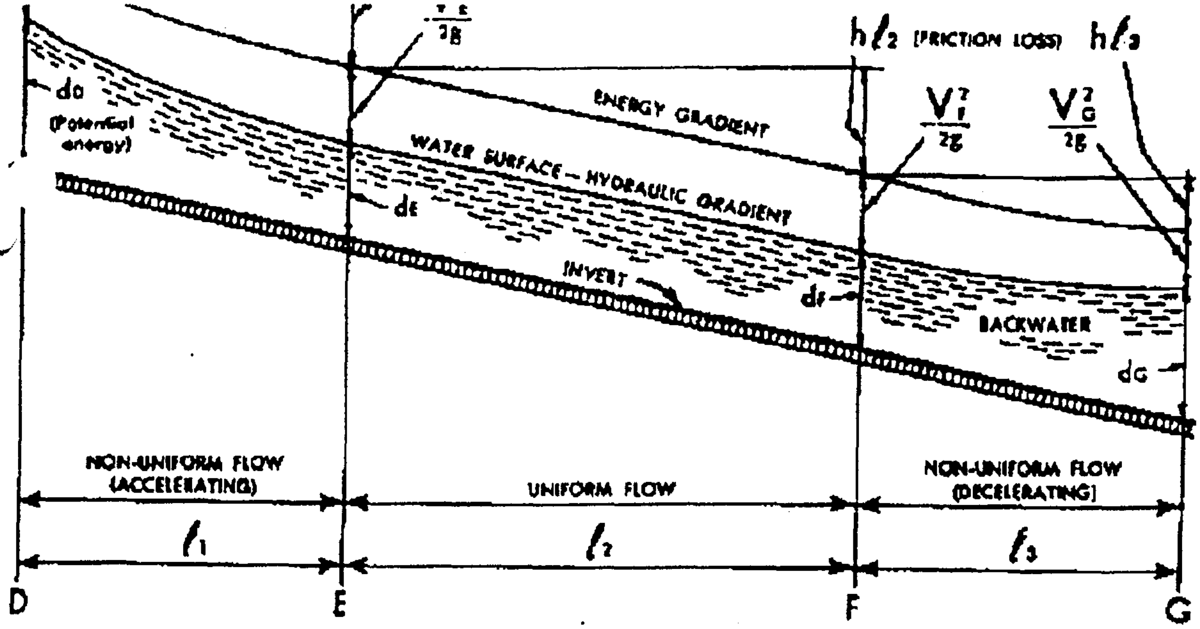
The flow in a pipe with a free water surface is defined as open channel flow. Steady flow means a constant quantity of flow and uniform flow means a steady flow in the same size conduit with the same depth and velocity. Although these conditions seldom occur in practice, it is necessary to assume uniform flow conditions in order to simplify the hydraulic design.

There are times when sewers become surcharged, encounter obstacles requiring an inverted siphon or require pumping. Under these conditions the sewer line will flow full and be under head or internal pressure.

The Flow Characteristics Diagram demonstrates the theory and terminology applied to flow in open channels. To simplify the diagram, all slopes are subcritical and it is assumed that at point D a constant supply of water or sewage is being supplied. Between D and E the slope of the conduit is greater than is required to carry the water at its initial velocity, and is greater than the retarding effect of friction, which causes acceleration to occur. At any point between E and F, the potential energy of the water equals the loss of head due to friction and the velocity remains constant. … is uniform flow. Between F and G the effect of downstream conditions are causing a decrease in the velocity.

Flow Characteristics Diagram





Note: All Slopes are Sub-critical.

The Hydraulic Profile

Three distinct slope lines are commonly referred to in hydraulic design of sewers as shown on page 18.

cases, the invert slopes downstream in the direction of flow.

2. **The Slope of the Hydraulic Gradient (H.G.).** This is sometimes referred to as the water surface. In open channel flow, this is the top surface of the liquid flowing in the sewer. Except for a few cases, the hydraulic gradient s' ~es downstream in the direction of flow.

. **The Energy Gradient (E.G.).** This is located above the hydraulic gradient, a distance equal to the velocity head which is the velocity squared divided by two times the acceleration due to gravity ($v^2/2g$). This slope is always downstream in the direction of flow. For uniform flow, the slope of the energy gradient, the slope of the hydraulic surface and the slope of the invert are parallel to one another but at different elevations.

Design Requirements

In sewer system design the following hydraulic requirements must be met:

1. The velocity must be sufficiently high to prevent the deposition of solids in the pipe but not high enough to induce excessive turbulence. The minimum scouring velocity is 2 feet per second. Clay pipe is being used successfully where velocities exceed 20 feet per second.

2. Where changes are made in the horizontal direction of the sewer line, in the pipe diameter, or in the quantity of flow, invert elevations must be adjusted in such a manner that the change in the energy gradient elevation allows for the head loss.

3. Sanitary sewers through 15-inch diameter are normally designed to run half-full at peak flow and larger sewers are designed to run three-quarters full at peak flow.

After flow estimates have been prepared, (page 15) including all allowances for future increases and the layout of the system has been determined, the next step is to establish the slope for each line. Using the land use map (page 1` working profile sheets are prepared. The profile sheets show the surface elevations, subsurface structures and other control points, such as house connections and other sewer connections. A typical profile for sewer design s shown on page 21.

Using the profile sheet, a tentative slope of the sewer is determined beginning at the lower end and working upstream between street intersections or control points. The slope is located as shallow as possible to serve the adjacent area and tributary areas with consideration to street grade and any control points or obstructions.

Determination of Pipe Sizes

Knowing the peak flow and the tentative slope, a tentative pipe size can be selected for each reach. Diagrams based on Manning's Equations showing quantity, slope, pipe size and velocity can be used to find pipe sizes. The diagrams show quantities for one-half depth for small pipe up through 15-inch diameter and three-quarters depth for 18-inch and larger sizes. The "n" values range from .010 to .013 (pages 24-27). Enter the diagram with Q and slope and read the larger pipe size. Except for cases where there are large head losses, the tentative pipe size will be the final pipe size.

Selecting the Sizes for the New Sewer Line

Using the flows (Qd) from the Sample Land Use Map (page 14), the pipe sizes may be selected after determining the slope of the line and the "n" value to be used.

The slope is obtained by drawing a preliminary profile showing control points, such as, sewers to be intercepted, major sub-structures, ground lines, outlet sewer, etc. The "n" value is selected by the user or specifying agency.

..ie available slope is .005 along this reach and "n" equal to .012 was selected for design, use the "n" = .012 esign Capacity Graph shown on page 26. Locate the intersection of the .005 slope and Qd and read the larger pipe size. In the reach downstream from MH A the Qd is .96 cfs. This Qd intersects the .005 slope between a 10-inch and a 12-inch pipe. The larger pipe is usually selected. In the reach downstream from MH B, the Qd is 1.53 cfs, indicating that a 15-inch pipe will be required. Further downstream, the outflow from MH F is 9.4 cfs, and a 21-inch pipe is necessary.

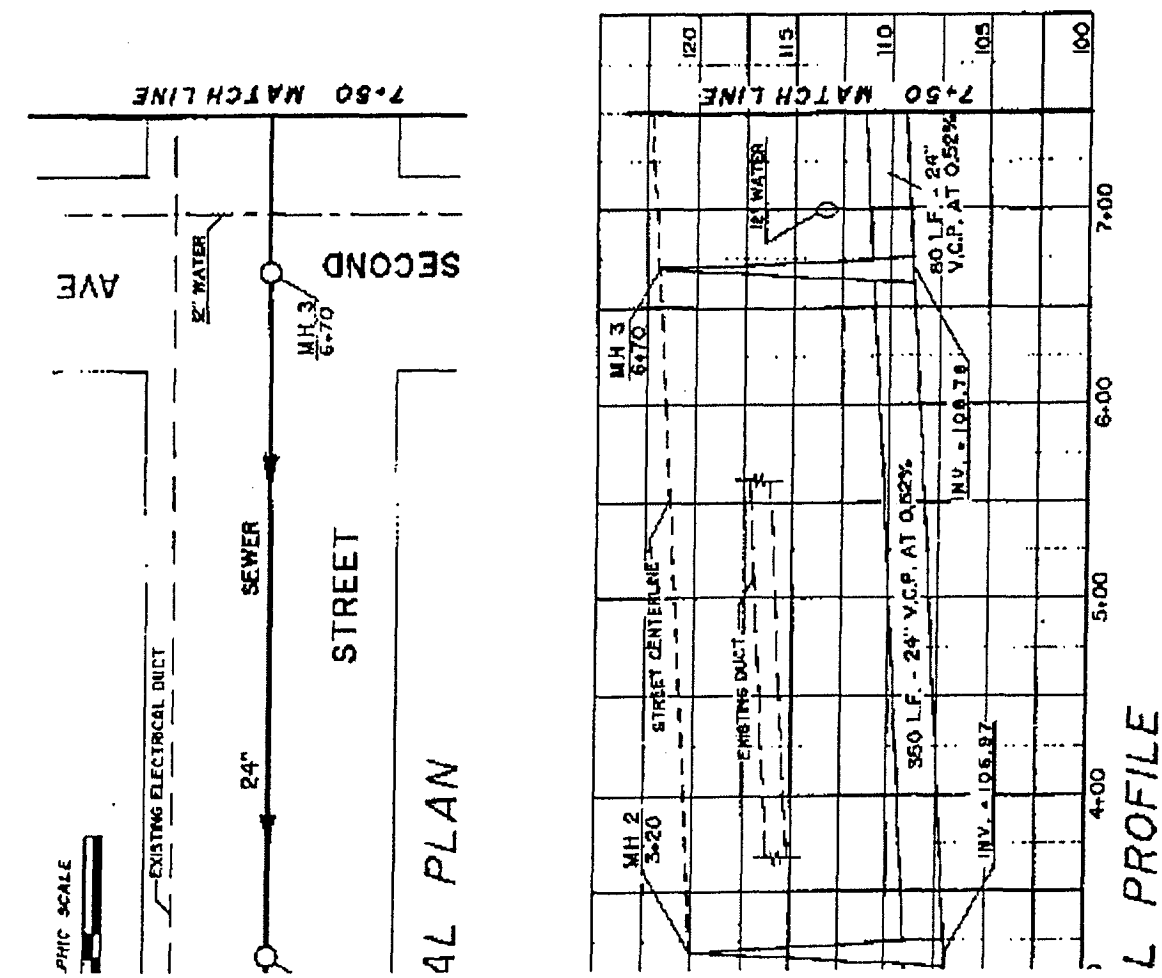
As a final check, plot the pipe lines on the profile, set the outlet elevation and work upstream through each confluence, making sure there is adequate clearance for substructures, and that the line meets all other controls. The pipe size will have to be rechecked if the slope has been changed for any reason.

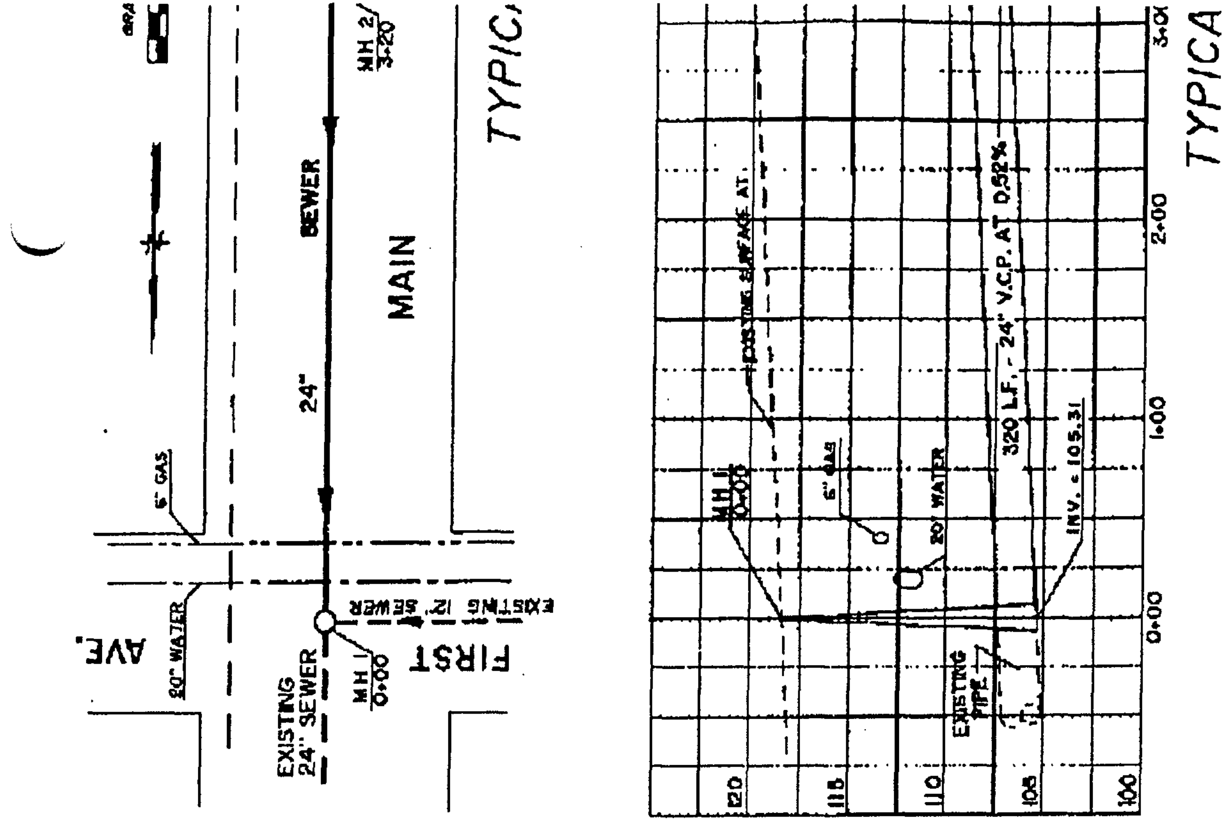
Knowing the quantity of flow and the pipe size, the velocity can be calculated using the Manning Equation, the Velocity Variation Table (page 22) or the design Capacity Graphs (pages 24-27). The velocity head can be calculated to give the Energy Gradient.

In many cases, especially with large diameter sewers, it is necessary to carefully plot the energy gradient of the sewer to determine that the hydraulic design requirements are met.

In these cases, start at the downstream end of the profile and mark the energy gradient at that point. Where the flow enters another sewer it will be the energy gradient of that sewer.

A line to represent a tentative location for the energy gradient for the first section of sewer being designed is then drawn upstream following the available surface slope to the next control point on the profile. As discussed earlier, this could be a point where flow is added, a street intersection, an abrupt change in surface slope or other control points. Care must be taken to see that the final design of the sewer provides adequate cover and that the sewer clears all subsurface obstructions. The profile can now be finalized.





Quantity and Velocity Equations

The following equations are provided to show the basis for flow diagrams and to supply equations for more accurate hydraulic calculations. The designer is reminded that precise calculations of hydraulic data are not possible except under controlled conditions.

The Manning Equations The most commonly used velocity and quantity equations are:

$V=(1.486/n)*R^{2/3}S^{1/2}$ (Velocity)

$Q=(1.486/n)*ar^{2/3}S^{1/2}$ (Quantity)

"V" is the velocity of flow (averaged over the cross-section of the flow) measured in feet per second. For sewers flowing at design depth, "V" should exceed 2 feet per second to prevent settlement of solids in the pipe. Conversely, velocities exceeding 20 feet per second should be avoided where possible. Clay Pipe can handle high velocities without damage, however, manholes, structures and angle points must be designed carefully to avoid problems.

"Q" is the quantity of flow measured in cubic feet per second.

"n" is a coefficient of roughness which is used in Manning's Equation to calculate flow in a pipe. (See the following discussion of "n" values.)

"a" represents the cross-sectional area of the flowing water in square feet.

"r" represents the hydraulic radius of the wetted cross-section of the pipe measured in feet. It is obtained by dividing "a" by the length of the wetted perimeter.

"s" represents the slope of the energy gradient. It is numerically equal to the slope of the invert and the hydraulic surface in uniform flow.

VELOCITY VARIATIONS FROM DESIGN DEPTHS
(To Convert Depth/Diameter to % of Velocity)

d/D	%V.5D	%V.75D	d/D	%V.5D	%V.75D
.05	26	23	.55	104	92
.10	40	35	.60	107	95
.15	52	46	.65	110	97
.20	62	54	.70	112	99
.25	70	62	.75	113	100
.30	78	69	.80	114	101
.35	84	74	.85	114	100
.40	90	80	.90	112	99
.45	95	84	.95	110	97
.50	100	88	1.00	100	88

Discussion of Values for "n"

The value of "n" for smooth bore pipe is affected by depth of flow, velocity of flow and quality of construction. In controlled experiments, using clean water, values of "n" under 0.009 have consistently been obtained for vitrified clay pipe and some other sewer materials. Many design engineers recommend that a more conservative value of "n" be used in design because of (1) the variations in "n" due to variable flow conditions, (2) the deposition of debris, grit and other foreign materials which find their way into a sewer system, (3) the build-up of slime and grease on all pipe surfaces, (4) the loss of hydraulic capacity of flexible pipe due to ring deflection and (5) misalignment due to construction or settlement. Based upon current data, it appears that "n" values of .010 - .013 can be applied to all types of smooth bore pipe. After pipe lines have been in place for several years, measurements may indicate "n" values which differ from the design value. These new values can be used for future flow calculations. Factors for determining Q's at different "n" values are shown on the Design Capacity Graphs (pages 24-27).

Computer Design

The National Clay Pipe Institute has developed a hydraulic design computer program using the Manning equations. The program can select pipe size, flow quantities or velocity in gravity flow sanitary sewers. It is available from the Institute or one of the member companies.

These photographs reproduced from "Flow of Water Through Culverts", Bulletin 1, University of Iowa Studies in Engineering, illustrate the effect of pipe smoothness on the flow.
Left: Flow is retarded by increased friction. Right: A typical smooth bore clay pipe.

ables: n=0.010, n=0.011, n=0.012, n=0.013

Conveyance Factors

Conveyance Factors equal Q/Qd expressed as a percent. Q is the amount of flow at any depth and Qd is the amount of flow when the depth is at design depth. Design depth for pipe 15-inch and smaller, is one-half full (.5D) and for pipe 18-inch and larger, three-quarters full (.75D). Depths are expressed in terms of d/D, where "d" is the depth and "D" is the diameter. The Conveyance Factor Tables are shown on page 29.

Examples 1 and 2 demonstrate the use of the .5D Table for pipe 15-inch and less in diameter.

Example No. 1 Determination of Percentage of Design Capacity of an Existing Sewer

The depth of flow measured in a 10-inch sewer is 0.35 feet. The diameter of a 10-inch pipe expressed in feet is 0.83 feet. Use the.5D Table, calculate d/D, 0.35 divided by 0.83, equals 0.42. Enter table with 0.42 (.4 vertical and .02 horizontal) and read 73%. For the size, slope and "n", read Qd from the appropriate Design Capacity Graph. If 1.2 cfs is the Qd then multiply by 0.73 to find Q equal to 0.9 cfs.

Example No. 2 Determination of the Depth of Flow When the Q is Known

The same 10-inch sewer has a design capacity of 1.2 cfs. The estimated flow will be 0.7 cfs. To find the depth, divide 0.7 by 1.2 which equals 58%. Enter Table with 58% and read d/D of 0.37. Multiply by the diameter 0.83 feet to find depth of 0.31 feet.

xamples 3 and 4 demonstrate the use of the .75D Table for pipe 18-inch and larger in diameter.

Example No. 3 Determination of Quantity of Flow

The depth of flow in a 21-inch sewer is 1.12 feet. d/D is 1.12 divided by 1.75 or 0.64. Use the .75D Table and read 81%. If the Qd from the Design Capacity Graph for this line is 9.2 cfs, multiply 81% times 9.2 for a Q of 7.5 cfs.

Example No. 4 Determination of Depth of Flow When the Q is Known

If the Q is 8 cfs and Qd is 9.2 cfs, divide 8 by 9.2 to find the Conveyance Factor of 87%. Enter the Table with 87% and read d/D of 0.67. The depth for a Q of 8 cfs is 0.67 times the diameter 1.75, which is 1.17 feet.

CONVEYANCE FACTOR TABLES

d/D to %Qd
d/D depth over Diameter
%Qd = Q at any depth divided by Q design

.5D TABLE FOR PIPE 15" AND SMALLER
For pipe 15" and smaller, Qd = Q at a depth of .5 Diameter

d/D	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	%	0	0	0	1	1	1	2	3	3
	4	5	6	7	8	10	11	13	14	16
.2	18	19	21	23	25	27	30	32	34	37

.3	39	42	44	47	50	52	55	58	61	64
.4	67	70	73	77	80	83	86	90	93	96
.5	100	103	106	110	113	117	120	124	127	131
.6	134	138	141	144	148	151	154	158	161	164
.7	167	170	173	176	179	182	185	188	190	193
.8	195	197	200	202	204	206	207	209	210	212
.9	213	214	214	215	215	215	214	213	211	208
1.0	200									

Example: The depth of flow in an 8" sewer was measured at .21' d/D = .21/.67= .31. Enter table for smaller sewers with d/D = .31 and read 42% Q design. Q design is read from Design Capacity Charts.

.75D TABLE FOR PIPE 18" AND LARGER
For pipe 18" and larger, Qd = Q at a depth of .75 Diameter

d/D	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	%	0	0	0	0	1	1	1	1	2
.1	2	3	3	4	5	5	6	7	8	9
.2	10	11	12	13	14	15	16	17	19	20
.3	21	23	24	26	27	29	30	32	34	35
.4	37	39	40	42	44	46	48	49	51	53
.5	55	57	59	60	62	64	66	68	70	72
.6	74	76	77	79	81	83	85	87	88	90
.7	92	94	95	97	99	100	102	103	105	106
.8	107	109	110	111	112	113	114	115	116	116
.9	117	118	118	118	118	118	118	117	116	114
1.0	110									

Example: The depth of flow in an 18" sewer was measured at 1.02' d/D = 1.02/1.5= .68. Enter table with d/D = .68 and read 88% of Q design. Q design is read from Design Capacity Charts.

APPENDIX Q

EXTRACTS
AMERICAN SOCIETY OF TESTING AND MATERIALS
STANDARDS FOR VITIRIFED CLAY PIPE

ASTM STANDARDS

The following ASTM Standards can be ordered from NCPI. Go to the Request Form to order the specification you need.

Designation

- C 12 — Standard Practice for Installing Vitrified Clay Pipe Lines[1]
- C 425 — Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings[1]
- C 700 — Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated[1]
- C 1208 — Vitrified Clay Pipe and Joints for Use in Jacking, Sliplining, and Tunnels[1]
- C 301 — Standard Test Methods for Vitrified Clay Pipe[1]
- C 828 — Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines[1]
- C 1091 — Standard Test Method for Hydrostatic Infiltration and Exfiltration Testing of Vitrified Clay Pipe Lines[1]
- C 896 — Standard Terminology Relating to Clay Products[1]

Designation:C 12

Standard Practice for Installing Vitrified Clay Pipe Lines[1]

1. Scope

1.1 This practice covers the proper methods of installing vitrified clay pipe lines in order to fully utilize the structural properties of such pipe.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Designation:C425

Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings[1]

1. Scope

1.1 This specification covers materials and test requirements for compression joints for vitrified clay pipe and f···ngs. See Specification C 700 for pipe specifications. The test requirements are applicable to pipe joint assemblies ı ,r to field installation of pipe.

1.2 Terminology C 896 can be used for clarification of terminology in this specification.

1.3 In developing the metric conversions used in the standards under the jurisdiction of Committee C-4, recognition has been made of the variable nature of clays, so that neither "soft" nor "hard" conversions, as they are defined in Practice E 380, have been made. For example, the inch is considered to be 25 mm instead of 25.4 mm.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

NOTE-Pipe should he installed in accordance with Practice C 12.

1.5 The following precautionary caveat pertains only to the Test Requirements portion, Section 7, of this standard. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicabi/ity of regulatory limitations prior to use.*

Designation:C700

Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated[1]

1. Scope

1.1 This specification establishes the criteria for acceptance, prior to installation, of extra strength and standard strength vitrified clay pipe and fittings to be used for the conveyance of sewage, industrial wastes, and storm water; and extra strength perforated and standard strength perforated vitrified clay pipe to be used for underdrainage, filter fields, leaching fields, and similar subdrainage installations.

1.2 The values stated in inch-pound units are to be regarded as the standard.

NOTE-Attention is called to Specification C425, Test Method C 828, Test Methods C 301, and Terminology C 896.

1.3 In developing the metric conversions used in the standards under the jurisdiction of Committee C-4, recognition has been made of the variable nature of clays, so that neither "soft" nor "hard" conversions, as they are defined in Practice F 380, have been made. For example, the inch is considered to be 25 mm instead of 25.4 mm.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 The following precautionary caveat pertains only to the Test Method portion, 5.2 through 5.2.3.2 of this standard: *This standard does not purport to address all of the saftety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the ɾ licability of regulatory limitations prior to use.*

Designation:C1208

Standard Specification for
Vitrified Clay Pipe and Joints for Use in Jacking, Sliplining, and Tunnels[1]

'cope

1.1 This specification establishes the criteria for the manufacture, quality assurance testing, inspection, installation, field acceptance testing, and product marking of vitrified clay pipe to be used in jacking, sliplining, in casings, and in tunnels for the conveyance of sewage, industrial wastes, and storm water.

1.1.1 Sections 3 through 6, and 8 of this specification contain manufacturing, quality assurance testing, inspection, and product marking criteria which are applicable to vitrified clay pipe prior to installation.

1.1.2 Section 7 of this specification contains criteria for the installation and field acceptance testing of vitrified clay pipe.

1.2 This specification also covers materials and test requirements for jointing of the pipe.

1.3 This specification is the companion to SI Specification C 1208M; therefore, no SI equivalents are shown in this specification.

1.4 *This standard does not purport to address all of the safety concerns,* if *any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

Designation:C301

Standard Test Methods for
Vitrified Clay Pipe[1]

1. Scope

1.1 These test methods cover the equipment for, and the techniques of, testing vitrified clay pipe prior to installation Tests using whole pipe determines the resistance to crushing and hydrostatic forces. Tests using pipe fragments measure the amount of water absorption of the pipe body and the quantity of acid-soluble material that may be extracted from it.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values stated in parentheses are for information only.

1.3 *This standard does not purport to address the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1-The following standards also apply to clay pipe and can be referenced for further information: Practice C 12 and Test Method C 828; Specifications C 425 and C 700.

Designation:C828

Standard Test Method for
Low-Pressure Air Test of Vitrified Clay Pipe Lines[1]

1. Scope

1 This test method defines procedures for testing vitrified clay pipe lines, using low-pressure air, to demonstrate the s⁻ıctural integrity of the installed line.

1.2 This test method shall be performed on lines after connection laterals, if any, have been plugged and braced adequately to withstand the test pressure, and after the trenches have been backfilled for a sufficient time to generate a significant portion of the ultimate trench load on the pipeline. The time between completion of the backfill operation and low-pressure air testing shall be determined by the approving authority.

1.3 This test method may also be used as a preliminary test, which enables the installer to demonstrate the condition of the line prior to backfill and further construction activities.

1.4 This test method is suitable for testing gravity-flow sewer pipe constructed of vitrified clay or combinations of clay and other pipe materials.

1.5 Definitions C 896, is to be used for clarification of terminology in this test method.

1.6 In developing the metric conversions used in the standards under the jurisdiction of Committee C-4, recognition has been made of the variable nature of clays, so that neither "soft" nor "hard" conversions, as they are defined in Practice E 380, have been made. For example, the inch is considered to be 25 mm instead of 25.4 mm.

1.7 The values stated in inch-pound units are to be regarded as the standard.

1.8 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

Designation:C1091

Standard Test Method for Hydrostatic Infiltration and Exfiltration Testing of Vitrified Clay Pipe Lines[1]

1. Scope

1.1 This test method defines procedures for hydrostatically testing vitrified clay pipe lines, to demonstrate the structural integrity of the installed line.

1.2 This test method is suitable for testing gravity-flow pipe lines constructed of vitrified clay pipe or combinations of clay pipe and other pipe materials.

1.3 This test method is applicable to the testing of the pipe lines only. Manholes or other structures should be tested separately.

1.4 The values stated in inch-pound units are to he regarded as the standard. The values given in parenthesis are provided for information only.[2]

This standard may involve hazardous materials, operations, and equipment. This standard does not purport to ɿudress all of the safety problems associated with its use. It is the responsibility of the iser of this standard to establish appropiate safety and health practices and determine the applicability of regilatory limitations prior to use.

ASTM Designation:C896

Standard Terminology Relating to Clay Products[1]

approving authority-the individual official, board, department, or agency established and authorized by a state, county, city, or other political subdivision, created by law to administer and enforce specified requirements.

backfill-all the material used to fill the trench from bedding to finished surface.

backfill, final-material used to fill the trench from initial backfill to finished surface.

backfill, initial-material used to fill the trench from top of bedding to a designated height over the pipe.

backfill, unconsolidated-non-compacted material in place in the trench.

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Standard Practice for Installing Vitrified Clay Pipe Lines[1]

This standard is issued under the fixed designation C 12; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This practice has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice covers the proper methods of installing vitrified clay pipe lines in order to fully utilize the structural properties of such pipe.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 301 Test Methods for Vitrified Clay Pipe[2]
C 425 Specification for Compression Joints for Vitrified Clay Pipe and Fittings[2]
C 700 Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated[2]
C 828 Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines[2]
C 896 Terminology Relating to Clay Products[2]
C 1091 Test Methods for Hydrostatic Infiltration and Exfiltration Testing of Vitrified Clay Pipe Lines[2]

3. Terminology

3.1 *General*—Terminology C 896 can be used for clarification of terminology in this specification.

DESIGN CONSIDERATIONS

4. Supporting Strength

4.1 The field supporting strength of vitrified clay pipe is materially affected by the methods of installation. The field supporting strength of a pipe is defined as its capacity to support dead and live loads under actual field conditions. It is dependent upon two factors: (*1*) the inherent strength of the pipe and (*2*) the bedding of the pipe.

4.2 The minimum bearing strength requirement in accordance with Specification C 700, as determined by the 3-edge-bearing test of Test Methods C 301, is a measure of the inherent strength of the pipe.

4.3 The tests used to measure bearing strength determine relative pipe strengths but do not represent actual field conditions. Therefore, an adjustment called a load factor is introduced to convert minimum bearing strength to field supporting strength. The magnitude of the load factor depends on how the pipe is bedded. The relationship is:

$$\text{Field supporting strength} = \text{minimum bearing strength} \times \text{load factor}$$

4.4 A factor of safety greater than 1.0 and less than or equal to 1.5 shall be applied to the field supporting strength to calculate a safe supporting strength. The relationship is:

$$\text{Safe supporting strength} = \frac{\text{Field supporting strength}}{\text{Factor of safety}}$$

5. External Loads

5.1 The external loads on installed vitrified clay pipe are of two general types: (*1*) dead loads and (*2*) live loads.

5.2 For pipes installed in trenches at a given depth, the dead load increases as the trench width, measured at the top of the pipe, increases. Consequently, the trench width at the top of the pipe shall be kept as narrow as possible. Pipe failure may result if the design trench width is exceeded. If the trench width exceeds the design width, a higher class of bedding, stronger pipe, or both, must be investigated.

5.3 Live loads that act at the ground surface are partially transmitted to the pipe. Live loads may be produced by wheel loading, construction equipment or by compactive effort. Compaction of embedment and backfill materials, beside and above the sewer pipe, produces a temporary live load on the pipe. The magnitude of the live load from compactive effort varies with soil type, degree of saturation, degree of compaction and depth of cover over the pipe. Care must be used in selection of compaction methods so that the combined dead load and live load does not exceed the field supporting strength of the pipe, or cause a change in its line or grade.

NOTE 1—For generally accepted criteria and methods for determining loads and supporting strengths, see *Gravity Sanitary Sewer Design and Construction, Water Pollution Control Federation Manual of Practice No. FD-5, American Society of Civil Engineers—Manuals and Report on Engineering Practice—No. 60.*[3]

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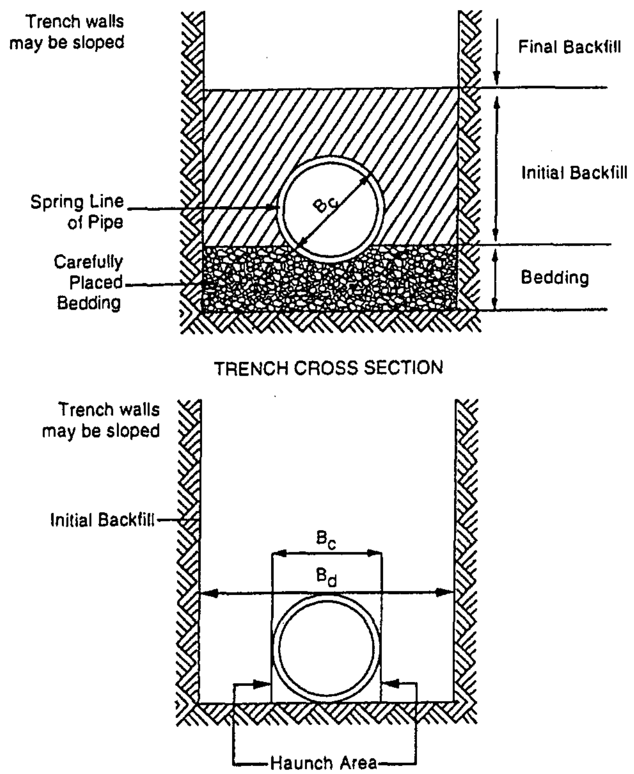
[1] This practice is under the jurisdiction of ASTM Committee C-4 on Vitrified Clay Pipe and is the direct responsibility of Subcommittee C04.20 on Methods of Test and Specifications.

Current edition approved Jan. 15, 1995. Published March 1995. Originally published as C 12 – 15 T. Last previous edition C 12 – 91.

[2] *Annual Book of ASTM Standards*, Vol 04.05.

[3] Available from American Society of Civil Engineers, 345 E. 47th Street, New York, NY 10017.



B_c = the outside diameter of the pipe barrel.
B_d = the design trench width measured at the horizontal plane at the top of the pipe barrel.

FIG. 1 Terminology

6. Bedding and Encasement

6.1 Classes of bedding and encasements for pipe in trenches are defined herein. The load factors indicated are for conversion of minimum bearing strength to field supporting strength.

6.2 *Class D* (Fig. 2)—The pipe shall be placed on the trench bottom with bell holes provided (Fig. 9). The initial backfill shall be of selected material (Note 2).

6.2.1 The load factor for Class D bedding is 1.1.

NOTE 2—Selected material is finely divided material free of debris, organic material, and large stones.

6.3 *Class C* (Fig. 3)—The pipe shall be bedded in carefully placed material (Note 3). However, shells, pea gravel, sand (see Note 4), or other locally available and commonly used bedding materials may be specified by the engineer in place of the previously described materials. The bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the haunches of the pipe one sixth of the outside diameter of the pipe. The initial backfill shall be of selected material (Note 2).

6.3.1 The load factor for Class C bedding is 1.5.

NOTE 3—"Carefully placed" material shall mean material that has been spaded or shovel-sliced so that the material fills and supports the haunch area and encases the pipe to the limits shown in the trench diagrams (Figs. 1-8). This practice calls special attention to the desirability of using well-graded ¾ to ¼ in. (19 to 6 mm) crushed stone or other non-consolidating bedding material not subject to migration. Where crushed material is not readily available, locally available and commonly used materials are acceptable, if used with engineering judgment as to their ability to provide adequate pipe support.

NOTE 4—Sand is suitable as a bedding material in a total sand environment but may be unsuitable where high and rapidly changing water tables are present in the pipe zone. It may also be undesirable for bedding, or haunching in a trench cut by blasting or in trenches through clay type soil.

6.4 *Class B* (Fig. 4)—The pipe shall be bedded in carefully placed material (Note 3). The bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the haunches of the pipe to the springline. The initial backfill shall be of selected material (Note 2).

6.4.1 The load factor for Class B bedding is 1.9.

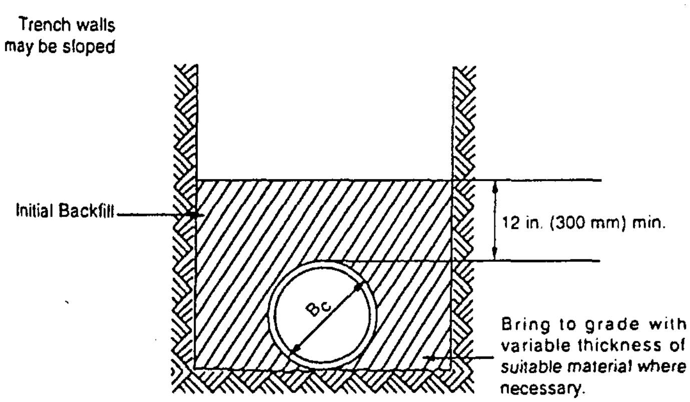
6.5 *Crushed Stone Encasement* (Fig. 5)—There are specific sites where crushed stone encasement may be desirable. The crushed stone shall extend to the specified trench width and shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one eighth of the outside diameter of the pipe, whichever is greater, and shall extend upward to a horizontal plane at the top of the pipe barrel, (Note 5). Encasement shall consist of well-graded ¾ to ¼ in. (19 to 6 mm) crushed stone or other non-consolidating bedding material not subject to migration. Material shall be carefully placed under the pipe haunches (Note 3). The initial backfill shall be of selected material.

NOTE 5—**Caution:** Sufficient crushed stone shall be placed so that the bedding extends to a horizontal plane at the top of the pipe barrel following removal of any trench sheeting or boxes.

6.5.1 The load factor for crushed stone encasement is 2.2.

6.6 *Controlled Density Fill* (Fig. 6)—Controlled density fill has been shown to be an economic alternative to compacted bedding material. It assists in utilizing the inherent strength of the pipe, completely filling the haunch area, and reducing the trench load on the pipe.

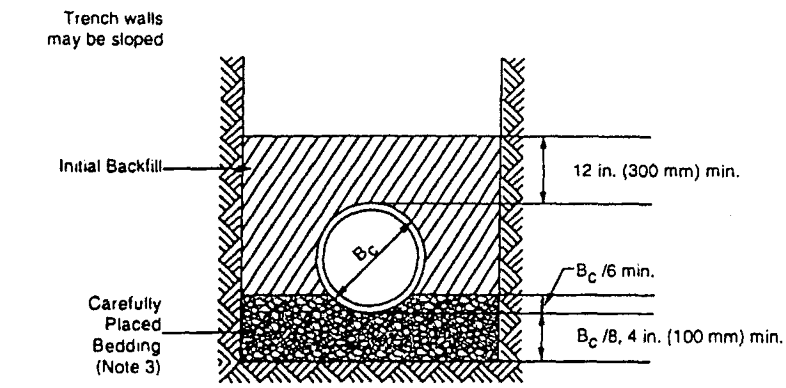
6.6.1 The pipe shall be bedded on crushed stone or other suitable material (Note 4). The bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one eighth of the outside diameter of the pipe, whichever is greater. Controlled density fill shall be directed to the top of the pipe to flow down on both sides to prevent misalignment. Fill to the top of the pipe. The initial backfill may be placed when the pour is capable of supporting the backfill material without intermixing.



Load Factor: 1.1

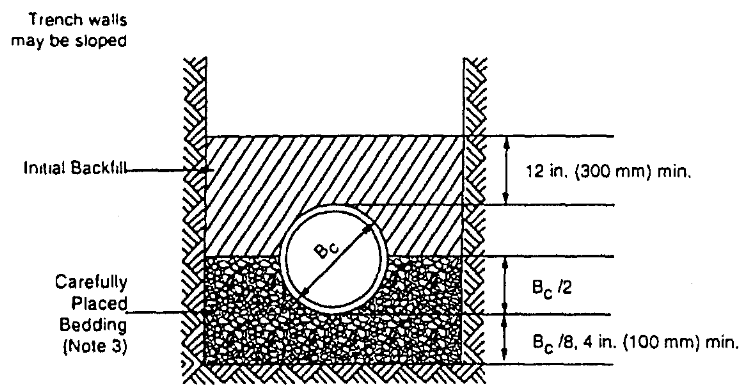
Flat or Restored Trench Bottom

FIG. 2 Class D



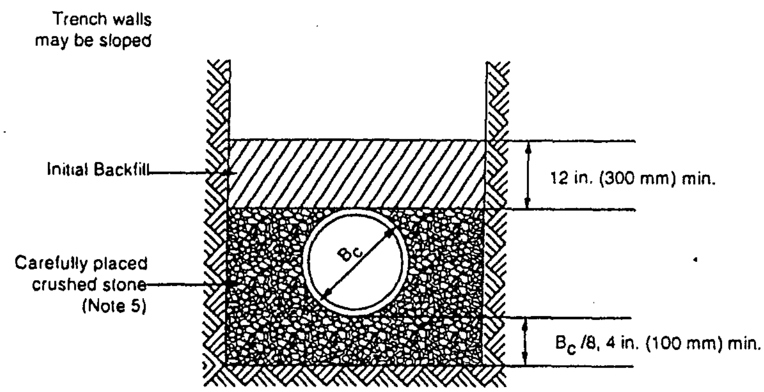
Load Factor: 1.5

FIG. 3 Class C



Load Factor: 1.9

FIG. 4 Class B



Load Factor: 2.2

FIG. 5 Crushed Stone Encasement

NOTE 6—Attention is directed to terminology and material references. See *American Concrete Institute Report: ACI 229R-94 Controlled Low Strength Materials (CLSM).*[4]

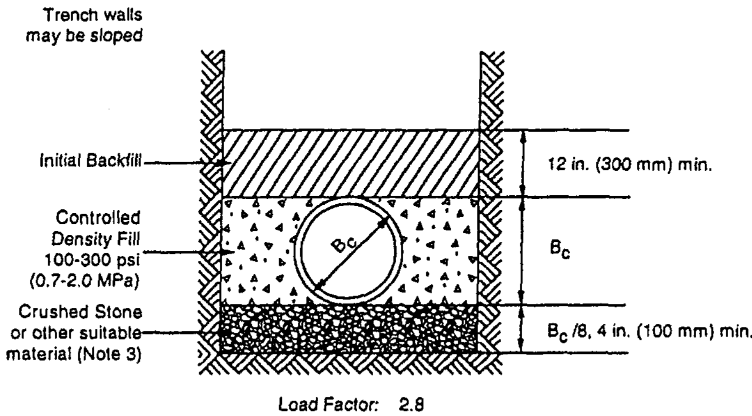
6.6.2 The load factor for controlled density fill is 2.8.

6.7 *Class A*—This class of bedding can be achieved with either of two construction methods.

6.7.1 *Concrete Cradle* (Fig. 7)—The pipe shall be bedded in a monolithic cradle of reinforced concrete having a thickness under the barrel of at least 4 in. (100 mm) or one fourth of the outside diameter of the pipe, whichever is greater, and extending up the haunches to a height of at least one fourth the outside diameter of the pipe. The cradle width shall be at least equal to the outside diameter of the pipe plus 4 in. (100 mm) on each side or one and one fourth times the outside diameter of the pipe, whichever is greater. If the trench width is greater than either of these dimensions, concrete may be placed to full trench width. The initial backfill shall be selected material.

6.7.1.1 The load factor for Class A concrete cradle bedding is 3.4 for reinforced concrete with $p = 0.4$ %, where p is

[4] Available from American Concrete Institute, P.O. Box 19150, Detroit, MI 48219-0150.



NOTE—This type of construction requires the fill to extend from the pipe to the trench wall. **Caution:** Where native soils are expansive, further evaluation may be necessary.

FIG. 6 Controlled Density Fill

the percentage of the area of transverse steel to the area of concrete at the bottom of the pipe barrel.

6.7.2 *Concrete Arch* (Fig. 8)—The pipe shall be bedded in carefully placed material (Note 3). The bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the haunches of the pipe to the springline. The top half of the pipe shall be covered with monolithic reinforced concrete arch with a minimum thickness from the top of the pipe barrel, of 4 in. (100 mm) or one fourth of the nominal diameter of the pipe, whichever is greater. The width of the arch shall be at least equal to the outside diameter of the pipe plus 4 in. (100 mm) on each side, or one and one fourth times the outside diameter, whichever is greater. If the trench width is greater than either of these dimensions, concrete may be placed to full trench width.

6.7.2.1 The load factor for Class A concrete; arch bedding is 3.4 for reinforced concrete with $p = 0.4$ %, and up to 4.8 for reinforced concrete with $p = 1.0$ %, where p is the percentage of the area of transverse steel to the area of concrete above the top of the pipe barrel.

6.8 *Concrete Encasement:*

6.8.1 There are specific sites where concrete encasement may be desirable. Concrete encasement shall completely surround the pipe and shall have a minimum thickness, at any point, of one fourth of the outside diameter of the pipe or 4 in. (100 mm), whichever is greater.

6.8.2 The encasement shall be designed to suit the specific use.

CONSTRUCTION TECHNIQUES

7. Trench Excavation

7.1 Trenches shall be excavated to a width that will provide adequate working space, but not more than the maximum design width. Trench walls shall not be undercut.

7.2 The trench walls can be sloped to reduce trench wall failure. This sloping will not increase the load on the pipe provided the measured trench width at top of pipe does not exceed the design trench width.

7.3 Trenches, other than for Class D bedding, shall be excavated to provide space for the pipe bedding.

7.4 Bell holes shall be excavated to prevent point loading of the bells or couplings of laid pipe, and to establish full-length support of the pipe barrel (Fig. 9).

7.5 Sheet, shore, and brace trenches, as necessary, to prevent caving or sliding of trench walls, to provide protection for workmen and the pipe, and to protect adjacent structures and facilities.

7.6 Sheeting shall not be removed below the top of the pipe if the resulting slope of native soil increases the trench width to such an extent that the load on the pipe exceeds the safe field supporting strength of the pipe and bedding system.

7.7 When a movable box is used in place of sheeting or shoring, secure the installed pipe to prevent it from moving when the box is moved.

7.8 It is preferable to keep the trench dry during all phases of construction. Exercise caution when terminating the dewatering procedure to avoid disturbing the pipe installation.

8. Pipe Bedding

8.1 Bedding shall be placed so that the pipe is true to line and grade and to provide uniform and continuous support of the pipe barrel.

9. Pipe Handling

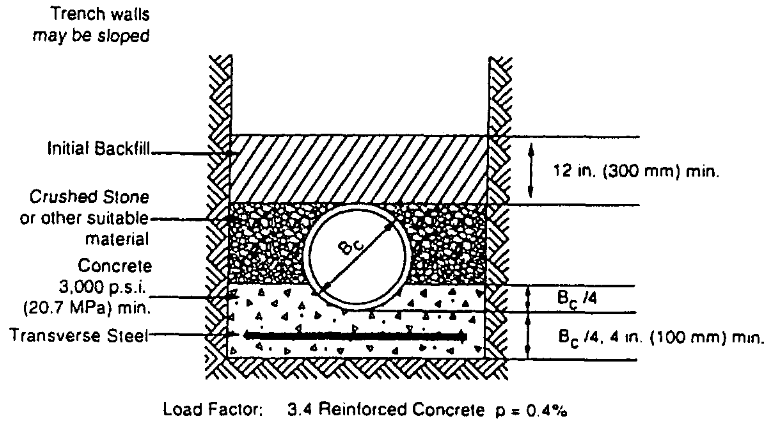
9.1 Pipe and fittings shall be handled so as to protect them

TABLE 1 Joint Deflection Limits

NOTE 1—For calculating the minimum radius of curvature use the following:
pipe—3 in. (75 mm) to 12 in. (300 mm) Diameter radius = 24 × pipe length
pipe—15 in. (375 mm) to 24 in. (600 mm) Diameter radius = 32 × pipe length
pipe—27 in. (675 mm) to 36 in. (900 mm) Diameter radius = 48 × pipe length
pipe—39 in. (975 mm) to 42 in. (1050 mm) Diameter radius = 64 × pipe length

Nominal Diameter, in. (mm)	Maximum Angular Deflection per Joint, degrees	Maximum Deflection of Pipe, in./linear ft (mm/linear m)
3–12 (75–300)	2.4°	½ (42)
15–24 (375–600)	1.8°	⅜ (31)
27–36 (675–900)	1.2°	¼ (21)
39–42 (975–1050)	0.9°	3/16 (16)

NOTE 2—Above material is applicable to compression joints for vitrified clay pipe and fittings in accordance with Specification C 425.



NOTE 1—Minimum width of concrete cradle: B_c + 8 in. (200 mm) or 1-¼ B_c.
NOTE 2—p is the ratio of the area of steel to the area of concrete. (It is recommended that wire mesh reinforcement or uniformly distributed small diameter rebar be used in all concrete design.)

FIG. 7 Concrete Cradle

from damage, especially damage due to impact, shocks, and free fall.

9.2 Carefully examine each pipe and fitting before installation, for soundness and specification compliance. Pipe accepted may be plainly marked by the inspector. Rejected pipe shall not be defaced, but shall be replaced with pipe that meets specification.

9.3 Handle pipe so that premolded jointing surfaces or attached couplings do not support the weight of the pipe. Do not damage the jointing surfaces or couplings by dragging, contact with hard materials, or by use of hooks.

10. Pipe Laying

10.1 Clean joint contact surfaces immediately prior to joining. Use joint lubricants and joining methods, as recommended by the pipe manufacturer.

10.2 Unless otherwise required, lay all pipe straight between changes in alignment and at uniform grade between changes in grade. Excavate bell holes for each pipe joint. When joined in the trench, the pipe shall form a true and smooth line.

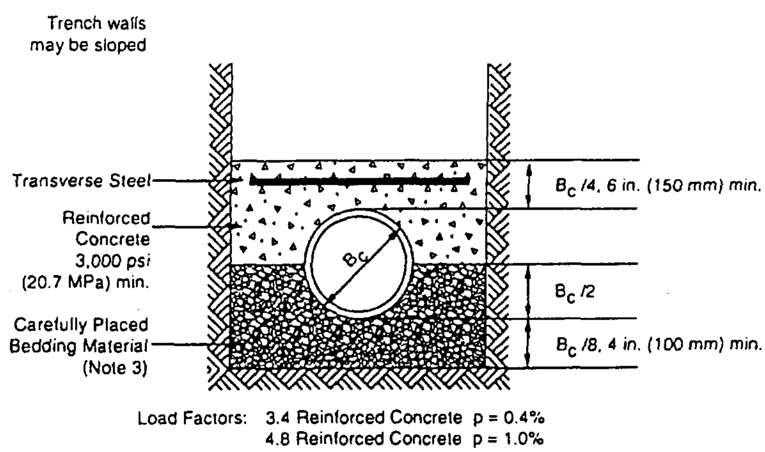
10.3 Straight lengths of pipe may be used for horizontal or vertical curves by uniformly deflecting each joint. The joint deflection limits shall be as described in Table 1.

10.4 Whenever practicable, start pipe laying at the lowest point and install the pipe so that the spigot ends point in the direction of flow to prevent bedding material from entering the joint.

10.5 After each pipe had been brought to grade, aligned, and placed in final position, deposit and shovel slice or spade bedding material under the pipe haunches. Wyes and tees shall be bedded to prevent shear loading.

10.6 Place pipe that is to be bedded in concrete cradle or encased in concrete, in proper position on temporary supports. When necessary, rigidly anchor or weight the pipe to prevent flotation as concrete is placed.

10.7 Place concrete for cradles, arches, or encasement uniformly on each side of the pipe and deposit at approximately its final position. Concrete placed beneath the pipe shall be sufficiently workable so that the entire space beneath the pipe can be filled without excessive vibration.



NOTE 1—Minimum width of concrete arch: B_c + 8 in. (200 mm) or 1¼ B_c.
NOTE 2—p is the ratio of the area of steel to the area of concrete. (It is recommended that wire mesh reinforcement or uniformly distributed small diameter rebar be used in all concrete design.)

FIG. 8 Concrete Arch

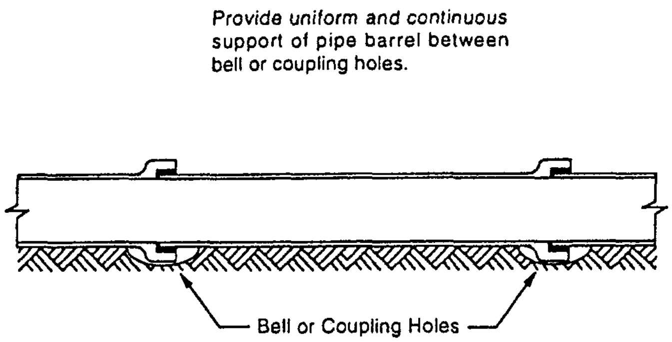


FIG. 9 Uniform Pipe Support

10.8 Where pipe connects with outside faces of manhole walls or the outside faces of the walls of other structures, provide a pipe joint such that slight flexibility or motion can take place in or near the plane of the wall face. It is recommended that a 12 to 18 in. (300 to 450 mm) pipe stub be extended from manhole or other wall faces. The pipe stub shall be bedded in the same manner as the pipe.

11. Backfilling Trenches

11.1 Initial backfill need not be compacted to develop field supporting strength of the pipe. Final backfill may require compaction to prevent settlement of the ground surface.

11.2 Unless otherwise directed, backfill trenches as soon as practicable after the pipe is laid. In the case of concrete bedding, delay backfilling until the concrete has set sufficiently to support the backfill load.

11.3 The initial backfill shall be of selected material (Note 2). Final backfill shall have no rock or stones having a dimension larger than 6 in. (150 mm) within 3 ft. (0.9 m) of the top of the pipe.

11.4 Puddling, jetting, or water flooding may be used for consolidating backfill material only when approved by the engineer.

12. Field Performance and Acceptance

12.1 After installation the sewer shall be tested for integrity by a method specified or approved by the engineer.

12.2 Where ground water exists, the line may be tested for infiltration by determining the quantity of water entering the system during a specified time period. Infiltration testing is recommended and shall conform to the test procedure described in Test Method C 1091.

12.3 Where ground water does not exist, either a water or low-pressure air test method may be used and shall be specified. The exfiltration test shall conform to the test procedure described in Test Method C 1091. Air testing shall conform to the test procedure described in Test Method C 828, and is recommended.

NOTE 7—When water or air tests are specified and the acceptance of a line depends upon satisfactory results, it should be recognized that several factors have a bearing on these results. Manhole bases, walls, and seals must be watertight. Household and commercial building and roof drains must be isolated. Stoppers must be sufficiently secured to be air or watertight.

12.4 In order for the performance of the line to be acceptable, all tests shall be made on pipe laid in accordance with the bedding provisions of Section 6. Joining procedures shall follow the recommendation of the pipe manufacturer.

13. Keywords

13.1 backfilling; bedding; clay pipe; compaction; construction; design; excavation; installation; load factors; pipe; sewers; trenching; vitrified

APPENDIX

(Nonmandatory Information)

X1. Installation Criteria for Perforated Vitrified Clay Pipe

X1.1 *Position of Perforations:*

X1.1.1 Perforations in a subdrain or leachate pipe shall normally be down.

X1.1.2 Under unique conditions it may be desirable to place the perforations up.

X1.2 *Method of Design:*

X1.2.1 Design in accordance with standard engineering practice, noting particularly, the bearing strength as listed in Specification C 700.

X1.3 *Bedding and Backfill:*

X1.3.1 Bedding and backfill shall be in accordance with the engineer's design.

X1.3.2 It is desirable to contain the bedding with a filter fabric.

X1.3.3 In the pipe zone the material shall be free draining without migration.

X1.3.4 Extreme care should be exercised in placement and compaction of backfill.

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Standard Test Methods for Vitrified Clay Pipe[1]

This standard is issued under the fixed designation C 301; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover the equipment for, and the techniques of, testing vitrified clay pipe prior to installation. Tests using whole pipe determines the resistance to crushing and hydrostatic forces. Tests using pipe fragments measure the amount of water absorption of the pipe body and the quantity of acid-soluble material that may be extracted from it.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values stated in parentheses are for information only.

1.3 *This standard does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—The following standards also apply to clay pipe and can be referenced for further information: Practice C 12 and Test Method C 828; Specifications C 425 and C 700.

2. Referenced Documents

2.1 *ASTM Standards:*

C 12 Practice for Installing Vitrified Clay Pipe Lines[2]

C 425 Specification for Compression Joints for Vitrified Clay Pipe and Fittings[2]

C 700 Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated[2]

C 828 Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines[2]

C 896 Terminology Relating to Clay Products[2]

E 6 Terminology Relating to Methods of Mechanical Testing[3]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in these test methods, refer to Terminology E 6 and Terminology C 896.

4. Significance and Use

4.1 *Meaning and Suitability*—The tests called for herein, from their results, indicate the suitability and acceptability of vitrified clay pipe for specifications acceptance, design purposes, regulatory statutes, manufacturing control, and research.

5. Bearing Strength

5.1 *Test Specimens:*

5.1.1 The test specimens shall be sound, full-size pipe and shall be selected by the purchaser, or his representative, at points he designates when placing the order.

5.1.2 The number of specimens to be tested shall not exceed 0.5 % of the number of pipe of each size furnished, except that no less than two specimens shall be tested.

5.2 *Measurement and Inspection of Specimens:*

5.2.1 The specimens shall be free of all visible moisture and frost. These specimens shall be inspected and measured for conformance with the applicable specifications. The results of these observations shall be recorded.

5.2.2 Specimens that are observed to have defects in excess of the limits permitted in the applicable specifications shall be discarded and replaced with additional specimens from the lot to be tested.

5.3 *Loading Apparatus* (see Fig. 1):

5.3.1 *Testing Machine:*

5.3.1.1 The loading apparatus shall consist of a testing machine capable of applying loads, with upper and lower bearings capable of transmitting these loads to the pipe. The bearings shall be bearing beams and contact edges.

5.3.1.2 Any motor driven testing machine that is capable of applying a load at a uniform rate of 2000 ± 500 lbf/min·linear ft (29.4 ± 7.4 kN/min·linear m) of pipe length, shall be used for making the test.

5.3.1.3 The load may be applied at a rapid rate until 50 % of the required bearing strength is reached. Subsequently, the load shall be applied to the pipe at a uniform rate of 2000 ± 500 lbf/min·linear ft (29.4 ± 7.4 kN/min·linear m) of pipe length without vibration or shock.

5.3.1.4 The testing machine shall be sufficiently rigid so that the load distribution will not be appreciably affected by the deformation or yielding of any part. The machine and bearings shall be constructed to transmit the load in a vertical plane through the longitudinal axes of the bearings and pipe. The

[1] These test methods are under the jurisdiction of ASTM Committee C-4 on Vitrified Clay Pipe and is the direct responsibility of Subcommittee C04.20 on Methods of Test and Specifications.

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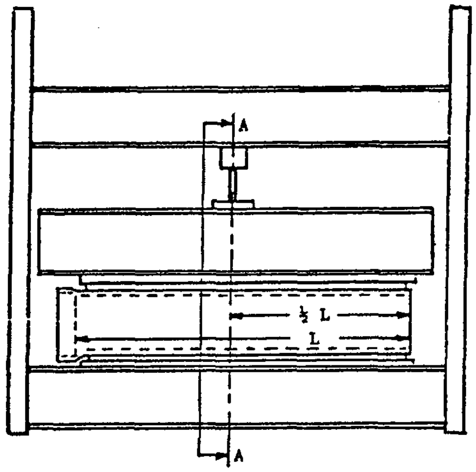
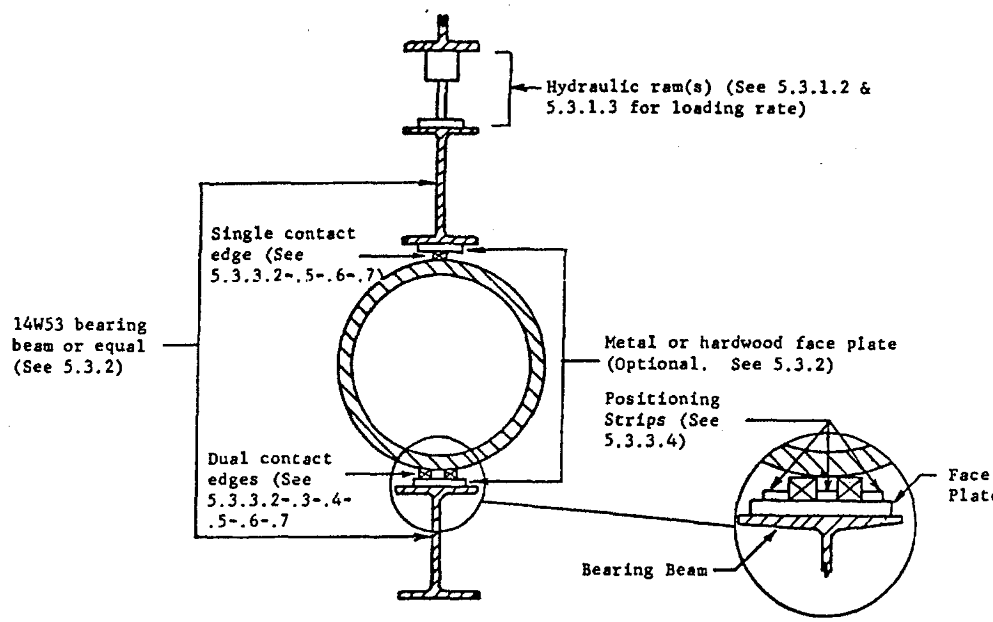
[2] *Annual Book of ASTM Standards*, Vol 04.05.

[3] *Annual Book of ASTM Standards*, Vol 03.01.





Section A-A

FIG. 1 Three-Edge Bearing Testing (see 5.3.4 for Segmented Testing)

bearings shall be attached to the machine so as to receive and uniformly transmit the loads required in the tests, without vibration or shock. The upper bearing shall be free to rotate in a vertical plane through the longitudinal axis of the bearing and the pipe.

5.3.2 *Bearing Beams*—Bearing beams shall not deflect more than a 14 by 8-in. (355 by 205-mm), 53-lb/linear ft (73-kg/linear m), wide flange beam as specified by the American Institute of Steel Construction. Under no circumstances shall the deflection in inches or millimetres under maximum load exceed that given by the ratio $L/720$ in which L is the beam length in inches or millimetres. The length of the bearing beams shall be no less than the full length of the outside barrel of the pipe. Built-up bearing beams may be used, provided their deflection does not exceed that specified. In order for the bell or socket of the pipe to clear the bearing beams, it is recommended that the bearing beams be faced with a metal or hardwood member for affixing the contact edges.

5.3.3 *Three-Edge Bearings*:

5.3.3.1 Three-edge bearings shall consist of an upper member, comprised of a bearing beam on which one contact edge is located so that it lies in the vertical plane passing through the longitudinal axis of the pipe; and a lower member comprised of a bearing beam on which two contact edges are symmetrically located parallel to that vertical plane.

5.3.3.2 The contact edges shall consist of rubber strips alone, or hardwood strips with plaster of paris fillets. Contact edges shall uniformly contact the outside barrel of the pipe.

5.3.3.3 The two contact edges on the lower member shall be spaced apart approximately 1 in./ft (83 mm/m) of pipe diameter, but in no case less than 1 in. (25 mm).

5.3.3.4 Positioning strips may be used to align the upper contact edge and to align and space the lower contact edges. In the case of rubber contact edges, positioning strips shall not exceed one half of the thickness of the contact edge and may remain in place.

5.3.3.5 If rubber strips are used as contact edges, they shall be cut or formed from material having a Shore A, instantaneous, durometer hardness between 45 and 60. The strips shall be of rectangular cross section, having a 2-in. (51-mm) width, and a thickness not less than 1 in. (25 mm) nor more than 1½ in. (38 mm). The contact edges shall be used with the 2-in. (51-mm) dimension in contact with the bearing beam. Rubber contact edges may be attached to the bearing beam by an adhesive, provided the contact edge remains firmly fixed in position.

5.3.3.6 If hardwood strips with plaster of paris fillets are used as contact edges, the strips shall be straight, and have a cross section not less than 1 in. (25 mm) in either direction. The bottom contact edges shall have vertical sides, with the interior top corners having a radius of approximately ½ in. (13 mm). The contact edges shall be securely fastened to the beams.

5.3.3.7 Plaster of paris fillets shall be cast on hardwood contact edges to provide uniform bearing contact on the pipe barrel. Fillets shall be cast on the two lower contact edges and on the upper contact edge, along the pipe crown. Sufficient excess plaster shall be removed from between the two lower contact edges to eliminate the possibility of a single continuous lower contact. The pipe and contact edges shall be joined while the plaster of paris is still workable. Testing shall be performed only after the fillets have set.

5.3.4 *Segmented Bearings (Alternative to Three-Edge Bearing)*—This apparatus shall consist of segmented upper and lower bearing members with the segments of each member connected to a common hydraulic manifold to provide uniform load along the length of the barrel. The segmented bearings shall be of uniform length with the number of segments equal to the nominal length of the test pipe measured in feet. They shall be adjustable to accommodate the length variation allowed in the pipe specification. In no instance shall the length of the segmented bearing be greater than the external length of the barrel of the pipe. Rubber contact edges conforming to 5.3.3.5 shall be attached to the bearing segments.

5.4 *Bearing Tests* (see Fig. 1):

5.4.1 Test pipe for bearing strength in accordance with the three-edge bearing or segmented method. Use either of the specified bearing methods on retests as provided in the applicable specifications.

5.4.2 For tests using rigid bearing beams, multiple loading rams may be used. Each ram must have the same load range, connected by a common hydraulic system, and spaced above the top bearing beam to deliver a uniformly distributed load. In testing pipe that is not straight, place it between the bearings in the position that most nearly gives uniform loading on the pipe.

5.4.3 The loading of the pipe shall be a continuous operation. Do not allow the pipe to stand under load longer than is required to apply the load and record the observations.

5.4.4 The loading shall be stopped after the required strength has been met.

5.4.5 For further evaluation or quality assurance, the loading may be continued to the point of pipe failure.

5.4.6 Record the maximum load sustained by the specimen.

5.5 *Calculation and Report*:

5.5.1 Calculate the bearing strength by dividing the applied load by the inside length of the barrel. The length shall be the average of two measurements taken at points 180° (3.1 rad) apart. Report the individual results of the tests of pipe of each size or lot.

6. Absorption

6.1 *Test Specimens*:

6.1.1 Absorption specimens shall be sound pieces of the full thickness of the barrel of the pipe, with all edges broken. Each specimen shall be as nearly square as possible, with the area on one barrel surface not less than twelve times the wall thickness, expressed as square units. They shall be free of observable cracks or shattered edges and shall not contain laminations and fissures more than is typical of the pipe from which the specimens were taken.

6.1.2 Each specimen shall be marked so that it may be identified with the lot of pipe from which it was taken. The markings shall be applied so that the pigment used shall cover not more than 1 % of the area of the specimen.

6.1.3 Test at least one specimen from each size of pipe.

6.2 *Weighing Apparatus*—The balance used shall be sensitive to 0.5 g when loaded with 1 kg, and weighings shall be made to at least the nearest 1 g. If other than metric weights are used, the same degree of accuracy shall be observed.

6.3 *Procedure*:

6.3.1 Dry the specimen at least 8 h in a ventilated oven at a temperature between 230 and 248°F (110 and 120°C), and make successive weighings at intervals of not less than 3 h until the loss at any weighing is not greater than 0.1 % of the original weight of the specimen.

6.3.2 Suspend the dried specimens in distilled, rain, or tap water that is known to have no effect on test results; heat to boiling; boil for 5 h, and then cool in the water to ambient temperature. Take care that no fragments are broken from the specimens by physical disturbance during the test. When cool, remove the specimens from the water, and drain for not more than 1 min. Then remove the superficial moisture by a damp cloth and weigh the specimens immediately.

6.4 *Calculation and Report*:

6.4.1 Calculate the absorption of each specimen as percentage of the initial dry weight as follows:

$$\text{Absorption, } \% = [(SW - DW)/DW] \times 100 \quad (1)$$

where:

DW = initial dry weight of specimen, and
SW = weight of specimen after boiling 5 h.

6.4.2 Report the result for each specimen, together with the averages for the pipe of each size and shipment.

7. Hydrostatic Pressure Test

7.1 When the pipe is subjected to an internal hydrostatic pressure of 10 psi (69 kPa) for the elapsed time shown in the following table, there shall be no leakage on the exterior of the pipe. At the option of the manufacturer, water within approximately 5°F (3°C) of the ambient air temperature may be introduced into the pipe for control of condensation. Moisture appearing on the surface of the pipe in the form of beads adhering to the surface shall not be considered leakage. However, moisture which starts to run on the pipe shall be construed as leakage regardless of quantity.

Testing Time for Pipes

Thickness of Barrel, in. (mm)	Test Time, min
Up to and including 1 (25)	7
Over 1 (25) and including 1½ (38)	9
Over 1½ (38) and including 2 (51)	12
Over 2 (51) and including 2½ (64)	15
Over 2½ (64) and including 3 (76)	18
Over 3 (76)	21

8. Acid Resistance

8.1 Determine the acid resistance of clay pipe by the extraction of acid-soluble matter.

8.2 *Reagent*—When testing with sulfuric (H_2SO_4), hydrochloric (HCl), nitric (HNO_3), or acetic acid (CH_3COOH), as specified by the purchaser, a 1 *N* acid solution shall be used.

NOTE 2—These 1 *N* solutions should contain, respectively, 49, 36.5, 63, and 60 g of the acid per litre of solution. For the purpose of these tests the solutions can be prepared by taking the following volumes of acid and diluting to 1 L: H_2SO_4(sp gr 1.84), 28.5 mL; HCl (sp gr 1.19), 88.9 mL; HNO_3(sp gr 1.42), 65 mL; and glacial acetic acid (sp gr 1.05), 57.7 mL.

8.3 *Test Specimens*:

8.3.1 The specimens for acid resistance tests shall be about 2 in. (50 mm) square, and weigh not more than 200 g. They shall be sound pieces with all edges freshly broken, free of cracks or shattered edges, and shall be thoroughly cleaned.

8.3.2 Test at least one specimen from each size of pipe.

8.4 *Weighing Apparatus*—The balance used in weighing the specimens shall be sensitive to 0.01 g when loaded with 200 g.

8.5 *Procedure*:

8.5.1 Dry the specimens to constant weight at a temperature not less than 230°F (110°C).

8.5.2 Suspend the dried specimens in the acid at a temperature between 70 and 90°F (21 and 32°C) for a period of 48 h, then remove them from the solution and thoroughly wash with hot water, allowing the washings to run into the solution in which the specimen was immersed. Filter the solution and wash the filter with hot water, adding the washings to the filtrate. Add 5 mL of H_2SO_4(sp gr 1.84) to the filtrate. Then evaporate the solution (avoid loss by spattering) to about 5 mL, transfer to a porcelain crucible (previously ignited to constant weight), and heat cautiously to dryness. Then ignite the residue to constant weight.

8.6 *Calculation and Report*:

8.6.1 Calculate the percentage of acid-soluble matter as follows:

$$\text{Acid-soluble matter, \%} = (R/W) \times 100 \quad (2)$$

where:
R = weight of residue, and
W = initial weight of the specimen.

8.6.2 Report the results for each specimen.

9. Visual Inspection

9.1 The specification for vitrified clay pipe requires visual inspection; reference should be made to Specification C 700.

10. Precision and Bias

10.1 No statements are made on the precision or bias of these test methods for measuring (*1*) bearing strength, (*2*) absorption, (*3*) acid resistance, or (*4*) moisture transmitted through the pipe wall in the hydrostatic pressure test, since conformance to specific criteria is the only measure for success specified in these test methods.

11. Keywords

11.1 absorption; acid resistance; bearing strength; clay pipe; corrosion; corrosion resistance; hydrostatic; inspection; loading; pipe; segmented bearing; testing procedure; tests; three-edge bearing; vitrified clay pipe

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Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings[1]

This standard is issued under the fixed designation C 425; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers materials and test requirements for compression joints for vitrified clay pipe and fittings. See Specification C 700 for pipe specifications. The test requirements are applicable to pipe joint assemblies prior to field installation of pipe.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

NOTE 1—Install pipe in accordance with Practice C 12.

1.3 The following precautionary caveat pertains only to the Test Requirements portion, Section 7, of this standard. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

A 167 Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip[2]

A 240/A 240M Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels[2]

C 12 Practice for Installing Vitrified Clay Pipe Lines[3]

C 700 Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated[3]

C 896 Terminology Relating to Clay Products[3]

D 395 Test Methods for Rubber Property—Compression Set[4]

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers— Tension[4]

D 471 Test Method for Rubber Property—Effect of Liquids[4]

D 518 Test Method for Rubber Deterioration—Surface Cracking[4]

D 543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents[5]

D 573 Test Method for Rubber—Deterioration in an Air Oven[4]

D 883 Terminology Relating to Plastics[5]

D 1149 Test Method for Rubber Deterioration—Surface Ozone Cracking in a Chamber[4]

D 1566 Terminology Relating to Rubber[4]

D 2240 Test Method for Rubber Property—Durometer Hardness[4]

3. Terminology

3.1 *Definitions*—Terms relating to plastics and rubber shall be as defined in Terminologies D 883 and D 1566, respectively.

3.2 Terminology C 896 can be used for clarification of terminology in this specification.

4. Principles of Joint Design

4.1 Sealing elements shall be compressed between bearing surfaces to assure watertight integrity as required in Section 7.

4.2 Sealing elements shall either be bonded to bearing surfaces or be independent elements.

5. Materials and Manufacture

5.1 Rubber ring-sealing elements shall conform to the requirements of Table 1.

5.2 Rubber for other than ring-sealing elements shall conform to the requirements of Table 2.

5.3 Plastic components shall conform to the requirements of Table 3.

5.4 Metallic components shall be of corrosion-resistant metal conforming to Specifications A 167 and A 240.

5.5 If any of the test specimens fail to meet the chemical resistance requirements, the manufacturer will be allowed a retest of two additional specimens, representative of the original material tested, for each one that failed. The jointing material will be acceptable if all retest specimens meet the test requirements.

5.6 Joints complying with this standard are suitable for most domestic and commercial applications. However, attention is

[1] This specification is under the jurisdiction of ASTM Committee C-4 on Vitrified Clay Pipe and is the direct responsibility of Subcommittee C04.20 on Methods of Test and Specifications.

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[2] *Annual Book of ASTM Standards*, Vol 01.03.

[3] *Annual Book of ASTM Standards*, Vol 04.05.

[4] *Annual Book of ASTM Standards*, Vol 09.01.

[5] *Annual Book of ASTM Standards*, Vol 08.01.

TABLE 1 Tests for Rubber—Ring-Sealing Elements

Test	Test Requirement	ASTM Standard
Chemical resistance:		D 543 [48 h at 23 ± 2°C (73.4 ± 3.6°F)]
1 *N* sulfuric acid	no weight loss	
1 *N* hydrochloric acid	no weight loss	
Tensile strength	1500 psi (10.3 MPa) min; 500 % min elongation at break	D 412
Hardness	Shore A durometer 35 min to 50 max	D 2240
Compression set	16 % max of original deflection	D 395, Method B [22 h at 70 ± 2°C (158 ± 3.6°F)]
Water absorption	5 % max	D 471—Immerse a 2-in. (50-mm) long section cut from a rubber-sealing element in distilled water for 7 days at 70 ± 2°C (158 ± 3.6°F)
Ozone resistance	no visible cracking under 2× specimen magnification using D 518, Procedure B, stretched 20 % and exposed to ozone concentrations of 0.5 ppm for 24 h at 40 ± 1°C (104 ± 1.8°F)	D 1149
Accelerated oven aging	80 % min of original tensile strength 75 % min of original elongation	D 573 [7 days at 70 ± 2°C (158 ± 3.6°F)]

TABLE 2 Tests for Rubber—Other than Ring-Sealing Elements

NOTE—Except for the water absorption test (Test Method D 471), the tests shall be run on buttons or specimens cut from rubber test slabs.

Test	Test Requirements	ASTM Standard
Chemical resistance:		D 543 [48 h at 23 ± 2°C (73.4 ± 3.6°F)]
1 *N* sulfuric acid	no weight loss	
1*N* hydrochloric acid	no weight loss	
Tensile strength	1000 psi (7 MPa) min; 250 % min elongation at break	D 412
Hardness	Shore A durometer 55 min to 70 max	D 2240
Compression set	20 % max of original deflection	D 395, Method B [22 h at 70 ± 2°C (158 ± 3.6°F)]
Water absorption	5 % max	D 471—Immerse a 2-in. (50-mm) long section cut from a rubber coupling in distilled water for 7 days at 70 ± 2°C (158 ± 3.6°F)
Ozone resistance	no visible cracking under 2× specimen magnification, using D 518, Procedure B, stretched 20 % and exposed to ozone concentrations of 0.5 ppm for 24 h at 40 ± 1°C (104 ± 1.8°F)	D 1149
Accelerated oven aging	85 % min of original tensile strength 85 % min of original elongation	D 573 [7 days at 70 ± 2°C (158 ± 3.6°F)]

TABLE 3 Tests for Plastic Materials

Test	Test Requirements	ASTM Standard
Chemical resistance:		D 543 (48 h at 23 ± 2°C)
1 *N* sulfuric acid	no weight loss	
1 *N* hydrochloric acid	no weight loss	

called to the fact that industrial effluents vary in content, concentration, duration of discharge and temperature; and specific evaluations of joint performance in such environments are necessary. In those instances, consult the manufacturer.

6. Joint Specimen Preparation

6.1 When required, assembled joints representative of the pipe and joints to be used, shall be selected from the supplier's stock by the purchaser or his representative.

6.2 Specimens selected for the test shall be up to 0.25 % of the number of joints to be furnished. No fewer than two assembled joints shall be tested for each diameter of pipe furnished.

6.3 Test specimens shall not be taken from damaged joints or pipe.

7. Test Requirements for Joints

7.1 Joints shall meet the requirements of 7.1.1 and 7.1.2 *or* 7.1.1 and 7.1.3, when subjected to an internal 10-ft (3.05-m) head of water pressure (4.3 psi (30 kPa)), for a period of 1 h. The recommended temperature of the water, pipe, and atmosphere is 60 to 75°F (16 to 24°C).

7.1.1 Joints shall not leak when tested in the straight position and when deflected to amounts shown in Table 4. The ends of the test line shall only be restrained the amount that is necessary to prevent longitudinal movement. The deflection shall be determined by measuring the distance the free end of one pipe moves away from the center line in any direction while the other pipe remains fixed.

7.1.2 Assembled joints shall not leak when subjected to shear. The shear load shall be a force of 150 lbf/in. (26.3 kN/m) of nominal diameter uniformly applied over an arc of not less than 120° (2.1 rad) along a longitudinal distance of 12 in. (305 mm) at the end of one pipe. The load is applied immediately adjacent to the assembled joint with the other pipe adequately secured and supported on blocks placed immediately adjacent to the joint.

7.1.3 Joints shall not leak when the jointed ends are displaced relative to one another in any direction perpendicular to

TABLE 4 Deflection

Nominal Diameter, in. (mm)	Deflection of Pipe, in./linear ft (mm/linear m)
3 to 12 (75 to 305), incl	½ (39)
15 to 24 (375 to 610), incl	⅜ (29)
27 to 36 (685 to 910), incl	¼ (19)
39 and 42 (980 and 1065)	³⁄₁₆ (15)

the pipe axes a distance of 0.04 in./in. (0.04 mm/mm) of pipe diameter.

8. Keywords

8.1 bell; chemical resistance; clay pipe; compression joints; corrosion resistance; couplings; deflection; joints; sealing elements; sewer; shear; testing

SUPPLEMENTARY REQUIREMENTS

These requirements apply only to Federal/Military procurement, not domestic sales or transfers.

S1. Government/Military Procurement

S1.1 *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the purchaser disapproves. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE S1.1—In U.S. Federal contracts, the contractor is responsible for inspection.

S2. Packaging and Marking for U.S. Government Procurement:

S2.1 *Packaging*—Unless otherwise specified in the contract, the materials shall be packaged in accordance with the supplier's standard practice in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

S2.2 *Marking*—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE S2.1—The inclusion of U.S. Government procurement requirements should not be construed as an indication that the U.S Government uses or endorses the products described in this document.

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Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines[1]

This standard is issued under the fixed designation C 828; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method defines procedures for testing vitrified clay pipe lines, using low-pressure air, to demonstrate the structural integrity of the installed line.

1.2 This test method shall be performed on lines after connection laterals, if any, have been plugged and braced adequately to withstand the test pressure, and after the trenches have been backfilled for a sufficient time to generate a significant portion of the ultimate trench load on the pipe line. The time between completion of the backfill operation and low-pressure air testing shall be determined by the approving authority.

1.3 This test method may also be used as a preliminary test, which enables the installer to demonstrate the condition of the line prior to backfill and further construction activities.

1.4 This test method is suitable for testing gravity-flow sewer pipe constructed of vitrified clay or combinations of clay and other pipe materials.

1.5 Terminology C 896 is to be used for clarification of terminology in this test method.

1.6 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 12 Practice for Installing Vitrified Clay Pipe Lines[2]

C 896 Terminology Relating to Clay Products[2]

3. Summary of Test Method

3.1 The section of the line to be tested is plugged. Air, at low pressure, is introduced into the plugged line. The line passes the test if the rate of air loss, as measured by pressure drop, does not exceed a specified amount in a specified time. This may be determined by the use of Table 1, or calculated by use of the formulas in Appendix X1.

4. Hazards

4.1 The low-pressure air test may be dangerous to personnel if, through lack of understanding or carelessness, a line is overpressurized or plugs are installed improperly. It is extremely important that the various plugs be installed so as to prevent the sudden expulsion of a poorly installed or partially inflated plug. As an example of the hazard, a force of 250 lbf (1112 N) is exerted on an 8-in. (205-mm) plug by an internal pressure of 5 psi (34 kPa). Observe the following safety precautions:

4.1.1 No one shall be allowed in the manholes during testing because of the hazards.

4.1.2 Install all plugs securely.

4.1.3 When lines are to be tested, it may be necessary that the plugs be braced as an added safety factor.

4.1.4 Do not overpressurize the lines.

5. Preparation of the Line

5.1 Air may pass through the walls of dry pipe. A wetted interior pipe surface is desirable and will produce more consistent test results. Usually moisture absorbed from the backfill is sufficient to cope with this situation. Where practical, clean the line prior to testing to wet the pipe surface and eliminate debris.

6. Procedure

6.1 Determine the test time for the section of line to be tested using Table 1 or Table X1.1 or the formulas in Appendix X1.

6.2 Plug all openings in the test section.

6.3 Add air until the internal pressure of the line is raised to approximately 4.0 psi (28 kPa). After this pressure is reached, allow the pressure to stabilize. The pressure will normally drop as the air temperature stabilizes. This usually takes 2 to 5 min, depending on the pipe size. The pressure should be reduced to 3.5 psi (24 kPa) before starting the test.

6.4 Start the test when the pressure is at 3.5 psi (24 kPa). If a 1 psi (7 kPa) drop does not occur within the test time, the line has passed. If the pressure drop is more than 1 psi (7 kPa) during the test time, the line is presumed to have failed the test. If the line fails the test, segmental testing may be utilized solely to determine the location of leaks, if any, but not for the

[1] This test method is under the jurisdiction of ASTM Committee C-4 on Vitrified Clay Pipe and is the direct responsibility of Subcommittee C04.20 on Methods of Test and Specifications.

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[2] *Annual Book of ASTM Standards*, Vol 04.05.

acceptance test as required by this section. (see X2.3.3.2.)

NOTE 1—Ground water above the pipe will reduce air loss. If the section of line under test shows significant infiltration, the agency may require an infiltration test. Refer to 11.2 of Practice C 12.

7. Test Time

7.1 Table 1 shows the required test time, *T*, in minutes/100 ft of pipe for each nominal pipe size. Test times are for a 1.0-psi (7-kPa) pressure drop from 3.5 to 2.5 psi (24 to 17 kPa). Table 1 has been established using the formulas contained in the appendix.

7.2 If the section of line to be tested includes more than one pipe size, calculate the test time for each size and add the test times to arrive at the total test time for the section.

7.3 It is not necessary to hold the test for the whole period when it is clearly evident that the rate of air loss is less than the allowable.

TABLE 1 Minimum Test Time for Various Pipe Sizes

Nominal Pipe Size, in. (mm)	*T* (time), min/100 ft	Nominal Pipe Size, in. (mm)	*T* (time), min/100 ft
		21 (535)	3.0
4 (100)	0.3	24 (610)	3.6
6 (150)	0.7	27 (685)	4.2
8 (205)	1.2	30 (760)	4.8
10 (255)	1.5	33 (840)	5.4
12 (305)	1.8	36 (915)	6.0
15 (380)	2.1	39 (990)	6.6
18 (455)	2.4	42 (1065)	7.3

APPENDIXES

(Nonmandatory Information)

X1. FORMULAS AND ALLOWABLE AIR LOSS STANDARDS USED IN TEST METHOD C 828

X1.1 Calculate the required test time at a given allowable air loss as follows:

$$T = K \times \frac{D^2L}{Q}$$

X1.2 Calculate air loss with a timed pressure drop as follows:

$$Q = K \times \frac{D^2L}{T}$$

X1.3 *Symbols*:

D = nominal size, in. (mm),
K = 0.371×10^{-3} for inch-pound units,
K = 0.534×10^{-7} for S.I. units,
L = length of line of one pipe size, ft (m),
Q = air loss, ft^3/min (m^3/min), and
T = time for pressure to drop 1.0 psi (7 kPa), min.

X1.4 An appropriate allowable air loss, *Q*, in cubic feet per minute, has been established for each nominal pipe size. Based on field experience, the *Q*'s that have been selected will enable detection of any significant leak. Table X1.1 lists the *Q* established for each pipe size.

TABLE X1.1 Allowable Air Loss for Various Pipe Sizes

Nominal, Pipe Size, in. (mm)	Q, ft^3/min	Nominal Pipe Size, in. (mm)	Q, ft^3/min
		21 (535)	5.5
4 (100)	2	24 (610)	6
6 (150)	2	27 (685)	6.5
8 (205)	2	30 (760)	7
10 (255)	2.5	33 (840)	7.5
12 (305)	3	36 (915)	8
15 (380)	4	39 (990)	8.5
18 (455)	5	42 (1065)	9

X2. APPLICATION OF TEST METHOD C828

X2.1 In order to demonstrate the technique of applying this test method, the example in X2.2 has been prepared. It utilizes various pipe sizes, lengths, and conditions that may be encountered in the field. The example has been designed to illustrate the use of Table 1 and the formulas.

X2.2 *Example*—An installation has been made that consists of line 1: 300 ft (91.4 m) of 15-in. (380-mm) vitrified clay pipe with no laterals, and line 2: a reach of 350 ft (106.8 m) of 8-in. (205-mm) of vitrified clay pipe to which are attached 120 ft (36.6 m) of 4 in. (100-mm) laterals of vitrified clay pipe.

X2.2.1 *Problem*—What are the appropriate test times to use in order to demonstrate the integrity of the installed lines?

X2.3 *Solutions*:

X2.3.1 What is the appropriate test time, *T*, for line 1?

X2.3.1.1 Use Table 1, find time, $T = 2.1$ min/100 ft (30.5

m), for 15-in. (380-mm) pipe.

$$T_{15} = 300 \times \frac{2.1}{100} = 6.3 \text{ min}$$

X2.3.2 What is appropriate time for line 2?

X2.3.2.1 *Solution*—Use Table 1.

$$T_8 = 350 \times \frac{1.2}{100} = 4.2 \text{ min}$$

$$T_4 = 120 \times \frac{0.3}{100} = 0.4 \text{ min}$$

Total test time 4.6 min

X2.3.3 If further analysis is desired, the following example is provided:

X2.3.3.1 If in the test of line 1, the 1.0-psi (7-kPa) pressure drop occurs in 3.3 min instead of 6.3 min, what is the rate of air loss?

$$Q = K \times \frac{D^2L}{T}$$

where:

$$Q = 0.000371 \times \frac{15^2 \times 300}{3.3} = 7.6 \text{ ft}^3/\text{min.}$$

This exceeds the 4 ft^3/min allowed in Table X1.1.

X2.3.3.2 What further courses of action might be considered in resolving this excess rate of air loss?

(1) Segmentally test the line and compare the time-air loss values in each segment.

(2) If the values in each segment are comparable, the air-loss problem may be distributed throughout the line, and further analysis should be made.

(3) If the values in each segment are significantly different, each segment may be evaluated and further analysis be made in order to determine the location of any significant air losses.

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Standard Test Method for Hydrostatic Infiltration and Exfiltration Testing of Vitrified Clay Pipe Lines[1]

This standard is issued under the fixed designation C 1091; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method defines procedures for hydrostatically testing vitrified clay pipe lines, to demonstrate the structural integrity of the installed line. Refer to Practice C 12.

1.2 This test method is suitable for testing gravity-flow pipe lines constructed of vitrified clay pipe or combinations of clay pipe and other pipe materials.

1.3 This test method is applicable to the testing of the pipe lines only. Manholes or other structures should be tested separately.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information only.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 12 Practice for Installing Vitrified Clay Pipe Lines[2]

C 828 Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines[2]

C 896 Terminology Relating to Clay Products[2]

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): The Modern Metric System[3]

3. Terminology

3.1 Terminology C 896 can be used for clarifications of terminology in this test method.

4. Summary of Test Method

4.1 This test method shall be performed on lines after connection laterals, if any, have been plugged and adequately braced to withstand the test pressure, and after the trenches have been backfilled for a sufficient time to generate a significant portion of the ultimate trench load on the pipe line. The time between completion of the backfill operation and hydrostatic testing shall be established by the approving authority.

5. Significance and Use

5.1 The tests called for herein, for their results, indicate the acceptability of installed vitrified clay pipelines.

6. Preparation of the Line

6.1 To ensure the proper seating of the test plugs and the accuracy of the test, the lines should be cleaned prior to testing.

6.2 Examples of methods for cleaning the lines are the sewer cleaning ball and high pressure flushing equipment.

7. Procedure

7.1 *Infiltration Testing*:

7.1.1 This test procedure is applicable where the measured water table is 2 ft (610 mm) or greater above the pipe barrel at the midpoint of the test section (see Note 1). Where the ground water elevation is indeterminate, less than 2 ft (610 mm) above the top of the pipe barrel, or the line is partially below the water table, use a combination of both the air test and infiltration procedure.

NOTE 1—What can be called false infiltration represents condensate on the pipe walls. This may amount to as much as 50 gal/in. diameter/mile/day (46.3 L/cm diameter/km/day). Thus, evaluate flow in the pipeline for this condition.

7.1.2 Determine the allowable infiltration rate for the test section using Table 1.

7.1.3 Discontinue all pumping of ground water for a period of 24 h prior to testing.

7.1.4 Plug the inlet to the test section to be tested. It is usually necessary to also plug the inlet of the upper manhole to prevent the manhole from filling with water or provide a method of de-watering the manhole or remotely removing the plug at the inlet to the test section. Securely plug all lateral inlets to the line.

7.1.5 To determine the infiltration rate, measure the flow at the outlet of the test section.

7.1.5.1 At the outlet of the test section, collect the water and measure the quantity collected within a specific time. Achieve collection and measurement with the use of a plug having a pipe outlet and a calibrated container after constant flow is

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[1] This test method is under the jurisdiction of ASTM Committee C-4 on Vitrified Clay Pipe and is the direct responsibility of Subcommittee C04.20 on Methods of Test and Specifications.

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[2] *Annual Book of ASTM Standards*, Vol 04.05.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

TABLE 1 Allowable Infiltration/Exfiltration Test Rate in Gal/100 ft of Line/Hour (litre/metre/hour)

nominal pipe size, in. (mm)	gal/100 ft/hour (L/m/h)	nominal pipe size in. (mm)	gal/100 ft/hour (L/m/h)
4 (100)	0.63 (0.05)	21 (535)	3.31 (0.25)
6 (150)	0.95 (0.07)	24 (610)	3.79 (0.28)
8 (205)	1.26 (0.09)	27 (685)	4.26 (0.32)
10 (255)	1.58 (0.12)	30 (760)	4.73 (0.35)
12 (305)	1.89 (0.14)	33 (840)	5.21 (0.34)
15 (380)	2.37 (0.18)	36 (915)	5.68 (0.42)
18 (455)	2.84 (0.21)	39 (990)	6.16(0.46)
...	...	42 (1065)	6.63 (0.49)

generated at the pipe outlet.

7.1.5.2 An alternate method of measurement is to use a calibrated weir (see Note 2) installed at the outlet of the test section and directly read the rate of flow.

NOTE 2—The apex of weir should be as near to the pipe invert as practical.

7.1.6 If the allowable infiltration rate (see Table 1) is exceeded, the line is presumed to have failed the test.

NOTE 3—The most practical method for testing is Test Method C 828, and is recommended. However, where ground water is present and meets the criteria established in 7.1.1, the infiltration test procedure outlined in this practice is recommended.

7.2 *Exfiltration Testing*—Although hydrostatic exfiltration testing is covered in this test method, it is suggested that the preferable test used in most cases is Test Method C 828. Coordinate Test Method C 828 with the infiltration test, outlined in this test method, where ground water is present, as described in 7.1.1.

7.2.1 Determine the allowable exfiltration rate for the test section using Table 1.

7.2.2 Plug the outlet of the test section being tested and brace securely. All lateral inlets shall be securely plugged.

7.2.3 Plug the inlet to the test section being tested and brace securely. This plug shall contain a fitting which will allow a standpipe to be attached.

7.2.4 Affix a standpipe with a minimum of 2-in. (50-mm) diameter to the plug and adequately support. The standpipe will be of sufficient length to provide a minimum 2-ft (610-mm) head over the pipe barrel at the upper end of the test section. The maximum head at any location in the test section shall not exceed 10-ft (3.05 m). If this is exceeded, it is necessary to either segmentally test the test section or conduct the air test (see Test Method C 828).

7.2.5 Add water to the test section and maintain the head for a minimum period of 4 h to allow for water absorption in the pipe or release of trapped air, or both.

7.2.6 Perform the test by maintaining the head in the standpipe by the addition of water and recording the volume of water added and the time elapsed.

7.2.7 If the water loss exceeds the allowable rate, the test section is presumed to have failed the test.

7.3 *Test Rate*:

7.3.1 The test rate table is based on the standard of 200 gal/in./diameter/mile/day, (in accordance with Practice C 12).

7.3.1.1 Table 1 shows the allowable infiltration/exfiltration rate in gallons per 100 ft (30.5 m) of pipe per hour for each nominal pipe size.

7.3.2 If the test section includes more than one pipe size, calculate the allowable test rate for each size and add to arrive at the total allowable test rate for the test section.

8. Testing Time

8.1 Terminate the infiltration test when sufficient water is collected or measured, or both, to establish the test rate.

8.2 Terminate the exfiltration test when sufficient water has been added to the standpipe to establish the test rate, but not less than 30 min.

9. Precision and Bias

9.1 No statement is made about either the precision or bias of this test method for measuring gallons (litres) and time, since the results merely state whether there is conformance to the criteria for success specified in the procedure.

10. Keywords

10.1 clay pipe; exfiltration; hydrostatic test; infiltration; infiltration-exfiltration test; pipe; pressure test; sewers; stand pipe; testing; test rate; test section; test time; vitrified clay pipe; water test

APPENDIX R

EXTRACTS
STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION

1999 SUPPLEMENT

TO

"GREENBOOK"

STANDARD SPECIFICATIONS

FOR

PUBLIC WORKS CONSTRUCTION

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Should the imported material not be substantially the same as the approved sample, it shall not be used for backfill and shall be removed from the Work site at the Contractor's expense.

The densification method for imported material authorized by the Engineer will be dependent upon its composition, the composition of the in-place soil at the point of placement, and the relative compaction to be obtained.

306-1.3.6 Transported Backfill. The Contractor may transport or back-haul material to be used as backfill material from any portion or line of a project to any other portion or line of the same project, or from any project being constructed under one contract to any other project being constructed under that same contract. Such transported material shall be clean soil, free from organic material, trash, debris, rubbish, or other objectionable substances except that broken portland cement concrete or bituminous type paving as specified in 306-1.3.1 may be included.

306-1.4 Testing Pipelines.

306-1.4.1 General. All leakage tests shall be completed and approved prior to placing of permanent resurfacing.

When leakage or infiltration exceeds the amount allowed by the specifications, the Contractor at its expense shall locate the leaks and make the necessary repairs or replacements in accordance with the Specifications to reduce the leakage or infiltration to the specified limits. Any individually detectable leaks shall be repaired, regardless of the results of the tests. Leakage tests shall be made on completed pipelines as follows:

1) Storm Drains - Not required unless called for on Plans or in Specifications.

2) Gravity Sanitary Sewers 600mm(24 inches) or less in diameter where difference in elevation between inverts of adjacent manholes is 3m(10 feet) or less - Water exfiltration test or water infiltration test as directed. The Engineer may allow substitution of an air pressure test for the water exfiltration test.

3) Gravity Sewers 600mm(24 inches) or less in diameter where difference in elevation between inverts of adjacent manholes is greater than 3m(10 feet) - Air pressure test or water infiltration test as directed.

4) Gravity Sewers 600mm(24 inches) or greater in diameter - Air pressure test or water infiltration test as directed.

5) Pressure Sewers (force mains) - Water pressure test at 120 percent of maximum operating pressure.

6) Water Pipelines - Water pressure test: Pipe specified by pressure classification, 350kPa(50 psi) over pressure classification. Other type of pipe, 120 percent of maximum operating pressure.

306-1.4.2 Water Exfiltration Test. Each section of sewer shall be tested between successive manholes by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers. The pipe and manhole shall be filled with water to a point 1.2m(4 feet) above the invert of the sewer at the center of the upper manhole; or if groundwater is present, 1.2m(4 feet) above the average adjacent groundwater level.

The allowable leakage will be computed by the formulae:

$E_{SI} = 0.00009 LD\sqrt{H}$ for mortared joints

($E_{US} = 0.0001\ LD\ V\sqrt{H}$ for mortared joints.)

$E_{SI} = 0.000018 LD\sqrt{H}$ for all other joints.

($E_{US} = 0.00002\ LD\ V\sqrt{H}$ for all other joints.)

Where:

L = length of sewer and house connections tested, in meters(feet).

E = the allowable leakage in liters(gallons) per minute of sewer tested.

D = the internal diameter of the pipe in millimeters (inches).

H = is the difference in elevation meters(feet) between the water surface in the upper manhole and the

the pipe at the lower manhole; or if groundwater is present above the invert of the pipe in the lower manhole, the difference in elevation between the water surface in the upper manhole and the groundwater at the lower manhole.

The Contractor shall, at its expense, furnish all water, materials and labor for making the required test. All tests shall be made in the presence of the Engineer.

306-1.4.3 Water Infiltration Test. If, in the opinion of the Engineer, excessive groundwater is encountered in the construction of a section of the sewer, the exfiltration test for leakage shall not be used.

The end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of groundwater shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.

The infiltration into each individual reach of sewer between adjoining manholes shall not exceed that allowed by the formula in 306-1.4.2 where H is the difference in the elevation in meters(feet) between the groundwater surface and the invert of the sewer at the downstream manhole.

Unless otherwise specified, infiltration will be measured by the Engineer using measuring devices furnished by the Agency.

306-1.4.4 Air Pressure Test. The Contractor shall furnish all materials, equipment, and labor for making an air test. Air test equipment shall be approved by the Engineer unless otherwise provided on the Plans or in the Specifications.

The Contractor may conduct an initial air test of the sewer mainline after densification of the backfill, but prior to installation of the house connection sewers. Such tests will be considered to be for the Contractor's convenience and need not be performed in the presence of the Engineer.

Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the sewer mainline and the upper ends of all house connection sewers

leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again. The Contractor has the option of wetting the interior of the pipe prior to the test.

The final leakage test of the sewer mainline and branching house connection sewers, shall be conducted in the presence of the Engineer in the following manner:

Air shall be introduced into the pipeline until 20 kPa(3.0 psi) gage pressure has been reached, at which time the flow of air shall be reduced and the internal air pressure shall be maintained between 17 kPa and 24 kPa(2.5 and 3.5 psi) gage pressure for at least 2 minutes to allow the air temperature to come to equilibrium with the temperature of the pipe walls. Pressure in the pipeline shall be constantly monitored by a gage and hose arrangement separate from hose used to introduce air into the line. Pressure in the pipeline shall not be allowed to exceed 34 kPa(5 psi) gage pressure.

After the temperature has stabilized and no air leaks at the plugs have been found, the air pressure shall be permitted to drop and, when the internal pressure has reached 17 kPa(2.5 psi) gage pressure, a stopwatch or sweep-second-hand watch shall be used to determine the time lapse required for the air pressure to drop to 10 kPa(1.5 psi) gage pressure.

If the time lapse (in seconds) required for the air pressure to decrease from 17 to 10 kPa(2.5 to 1.5 psi) gage pressure exceeds that shown in Table 306-1.4.4 (A), Low Pressure Air Test for Sewers, the pipe shall be presumed to be within acceptance limits for leakage.

If the time lapse is less than that shown in the table, the Contractor shall make the necessary corrections to reduce the leakage to acceptance limits.

1984 SUPPLEMENT TO

STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION

1982 EDITION

AMENDMENTS

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306-1.3.3 Water Densified Backfill. As used in these specifications, flooding shall mean the inundation of backfill with water, puddled with poles or bars to ensure saturation of the backfill material for its full depth. Jetting shall be accomplished by the use of a jet pipe to which a hose is attached, carrying a continuous supply of water under pressure.

Unless flooding is specified or otherwise authorized by the Engineer, all backfill to be densified by water shall be jetted.

The backfill shall be jetted in accordance with the following requirements:

1) The jet pipe shall consist of a minimum 1½ inch (38mm) diameter pipe to which a minimum 2 inch (50mm) diameter hose is attached at the upper end. The jet shall be of sufficient length to project to within 2 feet (0.6m) of the bottom of the lift being densified.
2) The Contractor shall jet to within 2 feet (0.6m) of the bottom of the lift and apply water in a manner, quantity and at a rate sufficient to thoroughly saturate the thickness of the lift being densified. The jet pipe shall not be moved until the backfill has collapsed and the water has been forced to the surface.
3) The lift of backfill shall not exceed that which can be readily densified by jetting, but in no case shall the undensified lift exceed 15 feet (4.5m).
4) Where the nature of the material excavated from the trench is generally unsuitable for densification with water, the Contractor may, at no cost to the Agency, import suitable material for jetting or densify the excavated material by other methods. The backfill shall be allowed to thoroughly drain until the surface of the backfill is in a firm and unyielding condition prior to commencement of any subsequent improvements. The Engineer may require the Contractor, at the Contractor's expense, to provide a sump and pump to remove any accumulated water.
5) The Contractor shall make its own determination that jetting will not result in damage and any resulting damage shall be repaired at the Contractor's expense.

306-1.3.4 Compaction Requirements. Except as specified otherwise, trench backfill shall be densified to the following minimum relative compaction:

1) 85 percent Relative Compaction:
   a) Between the pipe zone and the upper 3 feet (0.9m), measured from the pavement surface (or finish grade where there is no pavement) within native material or unengineered embankments.
   b) Outside the traveled way, shoulders and other paved areas (or areas to receive pavement).

   c) Under sidewalks.
2) 90 percent Relative Compaction:
   a) In the upper 3 feet (0.9m), measured from the pavement surface (or finish grade where there is no pavement), within the existing or future traveled way, shoulders, and other paved areas (or areas to receive pavement).
   b) Within engineered embankments.
   c) Where lateral support is required for existing or proposed structures.

306-1.3.5 Imported Backfill. If the Contractor elects to import material from a source outside the project limits for use as backfill, said materials shall be clean soil, free from organic material, trash, debris, rubbish, broken portland cement concrete, bituminous materials or other objectionable substances.

Whenever the Contractor elects to use imported material for backfill, it shall deliver, not less than 10 days prior to intended use, a sample of the material to the Engineer. The sample shall have a minimum dry weight of 100 pounds (45.4 kg) and shall be clearly identified as to source, including street address and community of origin. The Engineer will determine the suitability, the minimum relative compaction to be attained, and the placement method.

Should the imported material not be substantially the same as the approved sample, it shall not be used for backfill and shall be removed from the jobsite at the Contractor's expense.

The densification method for imported material authorized by the Engineer will be dependent upon its composition, the composition of the in-place soil at the point of placement, and the relative compaction to be obtained.

306-1.3.6 Transported Backfill. The Contractor may transport or back-haul material to be used as backfill material from any portion or line of a project to any other portion or line of the same project, or from any project being constructed under one contract to any other project being constructed under that same contract. Such transported material shall be clean soil, free from organic material, trash, debris, rubbish, or other objectionable substances except that broken portland cement concrete or bituminous type paving as specified in Subsection 306-1.3.1 may be included.

306-1.4 Testing Pipelines.

306-1.4.1 General. All leakage tests shall be completed and approved prior to placing of permanent resurfacing.

When leakage or infiltration exceeds the amount allowed by the specifications, the Contractor at its expense shall locate the leaks and make the necessary repairs or replacements in accordance with the specifications to reduce the leakage or infiltration to the specified limits. Any individually detectable leaks shall be repaired, regardless of the results of the tests. Leakage tests shall be made on completed pipelines as follows:

1) Storm Drains—Not required unless called for on plans or in Specifications.
2) Gravity Sanitary Sewers [24 inches (600mm) or less in diameter where difference in elevation between inverts of adjacent manholes is 10 feet (3.0m) or less]—Water exfiltration test or water infiltration test as directed. The Engineer may allow substitution of an air pressure test for the water exfiltration test.
3) Gravity Sewers [24 inches (600mm) or less in diameter where difference in elevation between inverts of adjacent manholes if greater than 10 feet (3.0m)]—Air pressure test or water infiltration test as directed.
4) Gravity Sewers [greater than 24 inches (600mm) in diameter]—Air pressure test or water infiltration test as directed.
5) Pressure Sewers (force mains)—Water pressure test at 120 percent of maximum operating pressure.
6) Water Pipelines—Water pressure test: Pipe specified by pressure classification, 50 psi (345 kPa) over pressure classification. Other type of pipe, 120 percent of maximum operating pressure.

306-1.4.2 Water Exfiltration Test. Each section of sewer shall be tested between successive manholes by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers. The pipe and manhole shall be filled with water to a point 4 feet (1.2m) above the invert of the sewer at the center of the upper manhole; or if ground water is present, 4 feet (1.2m) above the average adjacent ground water level.

The allowable leakage will be computed by the formulae:

$E = 0.0001\ LD\sqrt{H}$ for mortared joints.

$E = 0.00002\ LD\sqrt{H}$ for all other joints.

Where:

L is length of sewer and house connections tested, in feet.

E is the allowable leakage in gallons per minute of sewer tested.

D is the internal diameter of the pipe in inches.

H is the difference in elevation between the water surface in the upper manhole and the invert of the pipe at the lower manhole; or if ground water is present above the invert of the pipe in the lower manhole, the difference in elevation between the water surface in the upper manhole and the ground water at the lower manhole.

The Contractor shall, at its expense, furnish all water, materials and labor for making the required test. All tests shall be made in the presence of the Engineer.

306-1.4.3 Water Infiltration Test. If, in the opinion of the Engineer, excessive ground water is encountered in the construction of a section of the sewer, the exfiltration test for leakage shall not be used.

The end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of ground water shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.

The infiltration into each individual reach of sewer between adjoining manholes shall not exceed that allowed by the formula in Subsection 306-1.4.2 where H is the difference in the elevation between the ground water surface and the invert of the sewer at the downstream manhole.

Unless otherwise specified, infiltration will be measured by the Engineer using measuring devices furnished by the Agency.

306-1.4.4 Air Pressure Test. The Contractor shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the Engineer unless otherwise provided on the plans or in the Specifications.

The Contractor may conduct an initial air test of the sewer main line after densification of the backfill but prior to installation of the house connection sewers. Such tests will be considered to be for the Contractor's convenience and need not be performed in the presence of the Engineer.

Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the main sewer line and the upper ends of all house connection sewers. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.

The final leakage test of the sewer main line and branching house connection sewers, shall be conducted in the presence of the Engineer in the following manner:

Air shall be introduced into the pipeline until 3.0 psi (20kPa) gage pressure has been reached, at which time the flow of air shall be reduced and the internal air pressure shall be maintained between 2.5 and 3.5 psi (17 and 24kPa) (gage) for at least 2 minutes to allow the air temperature to come to equilibrium with the temperature of the pipe walls. Pressure in the pipeline shall be constantly monitored by a gage and hose arrangement separate from hose used to introduce air into the line. Pressure in the pipeline shall not be allowed to exceed 5 psi (34kPa) (gage).

After the temperature has stabilized and no air leaks at the plugs have been found, the air pressure shall be permitted to drop and, when the internal pressure has reached 2.5 psi (17kPa) (gage), a stop watch or

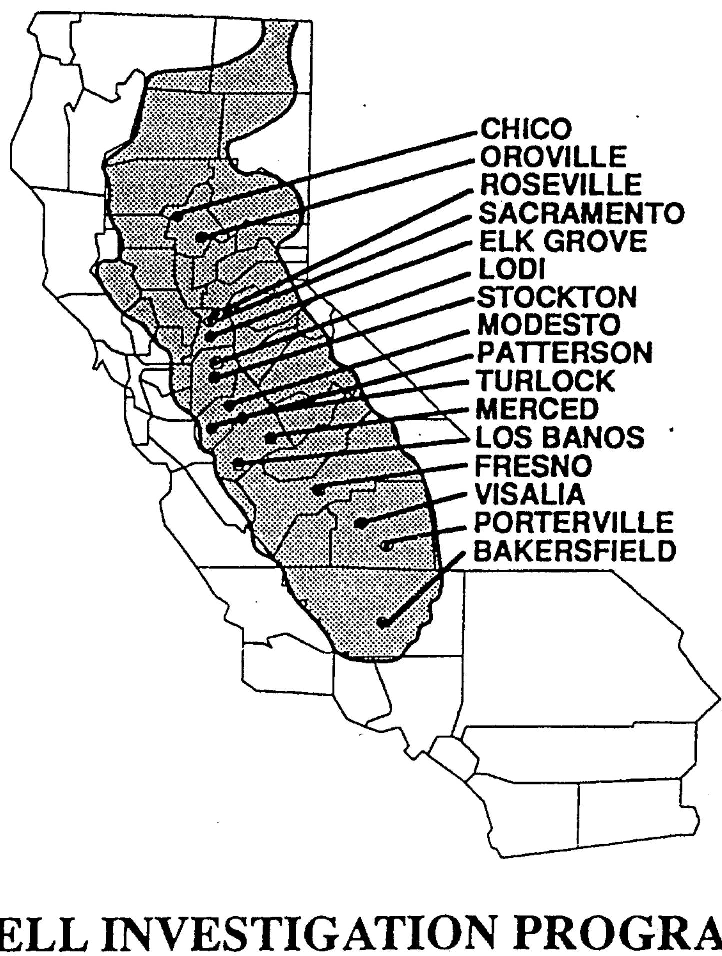
APPENDIX S

DRY CLEANERS – A MAJOR SOURCE OF PCE IN GROUNDEWATER MARCH, 1992

DRY CLEANERS— A MAJOR SOURCE OF PCE IN GROUND WATER

27 March 1992

CENTRAL VALLEY
CITIES WHERE MUNICIPAL WELLS ARE AFFECTED BY
TETRACHLOROETHYLENE (PCE)



WELL INVESTIGATION PROGRAM

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

3443 Routier Road, Suite A
Sacramento, California 95827-3098

Phone: (916) 361-5600
CALNET: 8-495-5600

DRY CLEANERS—A MAJOR SOURCE OF PCE IN GROUND WATER

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Associate Engineering Geologist

Approved by the California Regional Water Quality Control Board, Central Valley Region on 27 March 1992

INDEX

EXECUTIVE SUMMARY

Tetrachloroethylene (PCE), a known carcinogen, has degraded at least 215 wells in the Central Valley of California. Figure 1 illustrates the extent of the problem. The majority of these wells are large system municipal wells of 200 connections of more. The Chico, Sacramento, Modesto, Fresno, Turlock, Lodi and Merced areas all have wells with levels of PCE above 0.8 ppb which is the estimated one in a million incremental cancer risk (8). The Maximum Contaminant Level (MCL) set by the Department of Health Services for drinking water is five ppb. Forty-seven of the 215 wells have PCE levels above the MCL.

The Well Investigation Program of the Central Valley Regional Water Quality Control Board so far has identified the likely PCE sources in 21 of the wells; in 20 of those wells, dry cleaners are the likely source. In areas where PCE well investigations were done, dry cleaners are the only present large quantity users of this volatile organic chemical (VOC). The Halogenated Solvent Industry Alliance 1987 white paper on PCE states that dry cleaners use 56% of the PCE used in United States (5). All dry cleaners in the vicinity of degraded supply wells show evidence of major ground water degradation. Monitoring wells drilled adjacent to dry cleaners had concentration from 120 ppb to 32,000 ppb, well above the MCL.

The main discharge point for dry cleaners is the sewer line. The discharge from most dry cleaning units contains primarily water with dissolved PCE, but also contains some pure cleaning solvent and solids containing PCE. Being heavier than water, PCE settles to the bottom of the sewer line and exfiltrates through it. This liquid can leak through joints and cracks in the line. PCE, being volatile, also turns into gas and penetrates the sewer wall. Sewer lines are not designed to contain gas. The PCE then travels through the vadose zone to the ground water.

Where a source investigation has been done in connection with PCE contamination, the evidence has shown that dry cleaners have degraded the ground water. The data strongly indicate that leakage through

CENTRAL VALLEY
CITIES WHERE MUNICIPAL WELLS ARE AFFECTED BY PCE

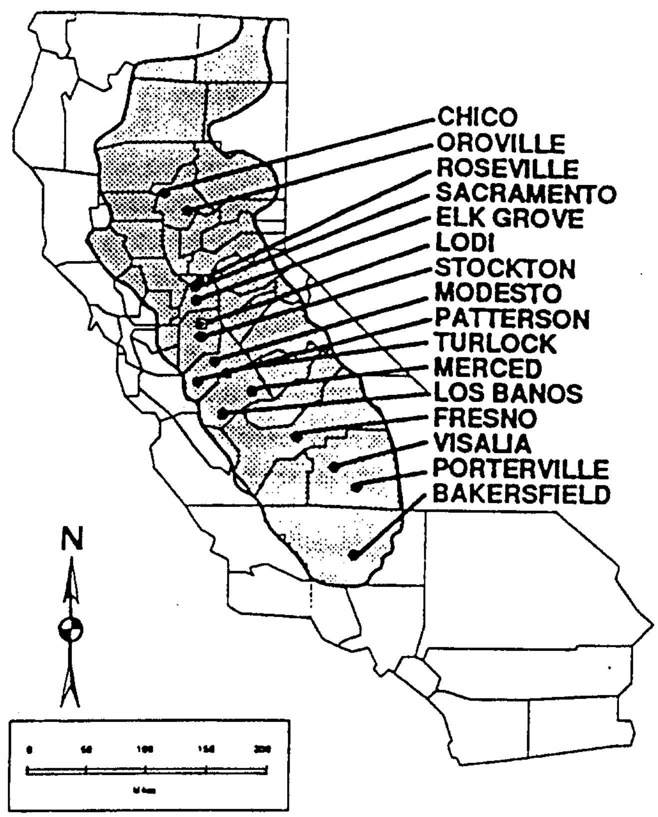


Figure 1

the sewer lines is the major avenue through which PCE is introduced to the subsurface. With approximately 285 dry cleaners in just the metropolitan areas of Sacramento, Chico, Lodi, Modesto, Turlock, Stockton and Merced, one would expect that many more wells will be degraded by PCE in the future. Most of the wells degraded by PCE and most of the dry cleaners are in residential and retail areas. Based on the data collected to date and the location of most of the degraded wells with confirmed PCE, a great majority of these wells will have dry cleaners as the source.

The solution to part of the problem is to halt the disposal of waste from dry cleaning units to the sewer line. Regulation of this discharge to the sewer could be achieved through new legislation and city ordinance. Since this problem exists throughout the state, a statewide policy seems appropriate.

The other part of the problem is ground water cleanup which is required so that cities can continue to provide safe water. A state wide fund may be needed to help pay for cleanup.

INTRODUCTION

Over 750 wells have been reported to the California Regional Water Quality Control Board, Central Valley Region, with confirmed levels of volatile organic chemicals (VOCs). Greater than 35% of the reported wells contain tetrachloroethylene (PCE). Municipal drinking water supplies have been affected by PCE throughout the Central Valley (Figure 1). At least one city is already treating contaminated ground water in order to continue its water supply.

This report discusses some of the data and conclusions about PCE movement to ground water, the source of the PCE, and possible solutions. The report is divided into six sections.

*Introduction

* Tetrachloroethylene (PCE)
  A brief description of the use of PCE and its physical and chemical properties.

* Source Identification for PCE Degraded Wells
  A description of how Board staff determines the source of VOC(s) in a well and the results of PCE source investigations.

* Dry Cleaning Operations and Discharge Locations
  General discussion of dry cleaning operations and waste discharge points.

* Evidence and Theory on How PCE is Leaving the Sewer

* Conclusion and Recommendations

TETRACHLOROETHYLENE (PCE)

PCE was first formulated in 1821 (22). By the 1960's and early 1970's, it had become a widely used solvent in dry cleaning, metal degreasing and other industries (18). In the late 1970's, most industries moved away from the use of PCE. The exception was the dry cleaning industry. By the early 1980's, dry cleaners used the majority of the PCE in this nation (18). In the late 1980's, dry cleaners used 56% of the PCE used in United States (5).

Compared to many VOCs, PCE is very mobile, with relatively low solubility and vapor pressure. In its liquid state, it is heavier and less viscous than water and will sink through it. In the vapor phase, PCE's density is greater than air. PCE biodegradability is low in the subsurface. The following are some of the physical and chemical properties of PCE: [3]

Molecular Weight	165.85 g
Solubility	150 mg/l at 25°C
Vapor Pressure	14 torr
Density	1.63 g/cm
Boiling Point	121 °C
Kinematic Viscosity	0.54 (water=l)
Henry's Law Constant	0.0131 atm-m /mole
Vapor Density	5.83 (air=1)
Specific Gravity	1.63 at 20° (water=l)
Relative Velocity	1.8 (water=l)

PCE is generally found in three phases in the subsurface: liquid, vapor, and dissolved in water. More than one phase usually exists in the subsurface after discharge. Figure 2 shows three possible scenarios at a discharge point.

VOCs will not adsorb to subsurface materials to any significant degree when those materials are nearly pure minerals which contain little organic matter. Most high-yield aquifers are nearly free of organic matter. The majority of fresh water aquifers and the vadose zone in the Central Valley are fan deposits from the Sierra Nevada and the Coast Range, and are composed primarily of low organic soils and substrata. Therefore, retention of VOCs in the Central Valley by soil and subsurface strata probably is very low.

PCE is a known carcinogen. The Water Quality Advisories for a l-in-a-million incremental cancer risk

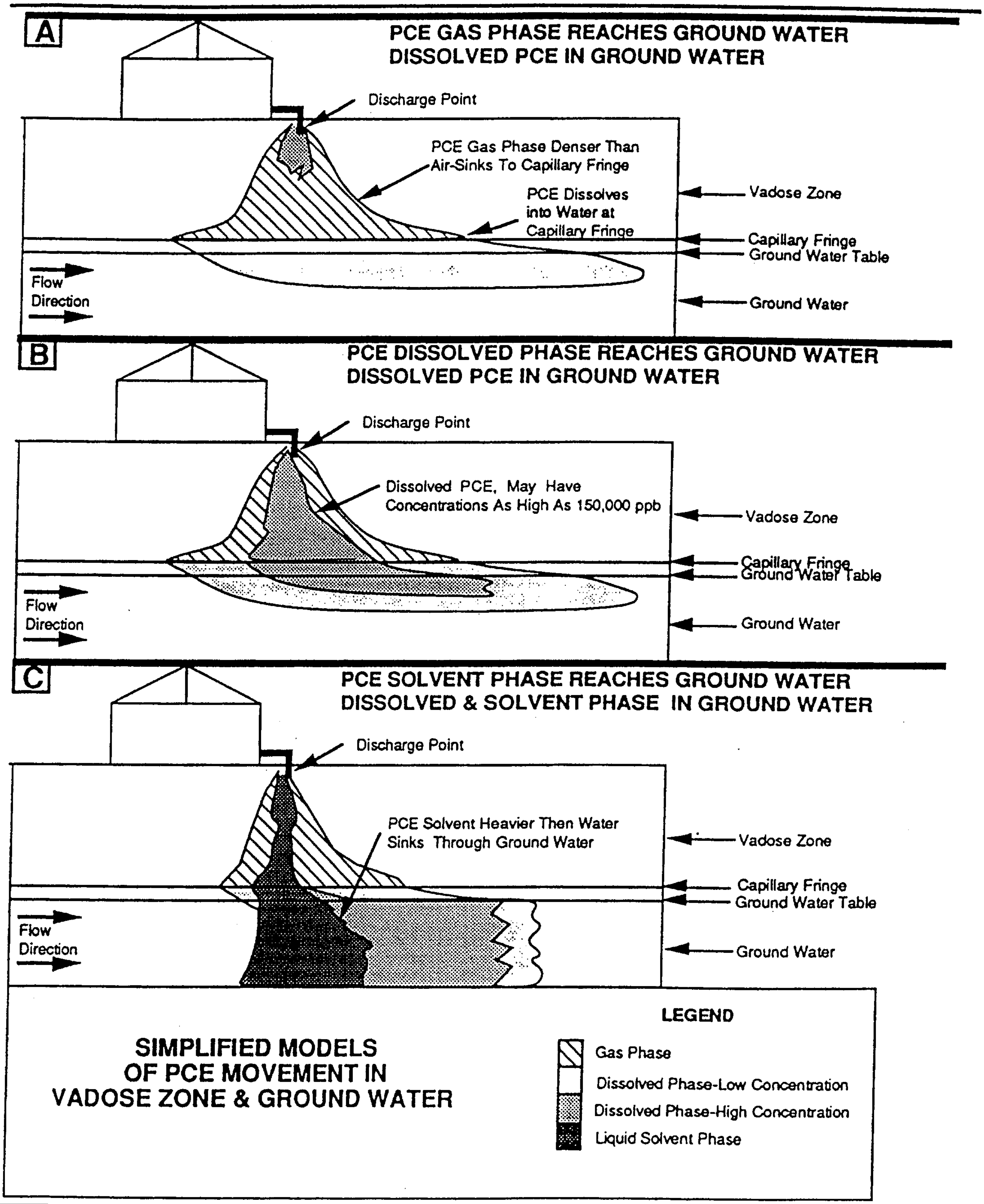

A
PCE GAS PHASE REACHES GROUND WATER
DISSOLVED PCE IN GROUND WATER
Discharge Point
PCE Gas Phase Denser Than Air-Sinks To Capillary Fringe
PCE Dissolves into Water at Capillary Fringe
Vadose Zone
Capillary Fringe
Ground Water Table
Flow Direction
Ground Water
B
PCE DISSOLVED PHASE REACHES GROUND WATER
DISSOLVED PCE IN GROUND WATER
Discharge Point
Dissolved PCE, May Have Concentrations As High As 150,000 ppb
Vadose Zone
Capillary Fringe
Ground Water Table
Flow Direction
Ground Water
C
PCE SOLVENT PHASE REACHES GROUND WATER
DISSOLVED & SOLVENT PHASE IN GROUND WATER
Discharge Point
PCE Solvent Heavier Then Water Sinks Through Ground Water
Vadose Zone
Capillary Fringe
Ground Water Table
Flow Direction
Ground Water
SIMPLIFIED MODELS OF PCE MOVEMENT IN VADOSE ZONE & GROUND WATER
LEGEND
Gas Phase
Dissolved Phase-Low Concentration
Dissolved Phase-High Concentration
Liquid Solvent Phase

Figure 2

estimate is 0.8 ppb (8). The State of California Department of Health Services Maximum Contaminant Level (MCL) for PCE is five ppb.

SOURCE IDENTIFICATION FOR PCE DEGRADED WELLS

A source investigation is conducted by Board staff to identify the source(s) of contaminant found in a drinking water supply well. This section is divided into two parts: a description of the steps in a source investigation and a general discussion of the results of a PCE source investigation.

SOURCE INVESTIGATION

There are five general steps conducted in a source investigation as follows:

1. Well reported degraded by VOCs
2. Identify possible sources of the VOCs
3. Inspect the users of the VOCs
4. Identify ground water characteristics
5. Conduct a soil gas survey

In step 1, a drinking water well is reported degraded by a VOC to the Board. The main sources of this information are the California Department of Health Services, counties, municipalities and private water companies. The information starts the Board's formal source investigation.

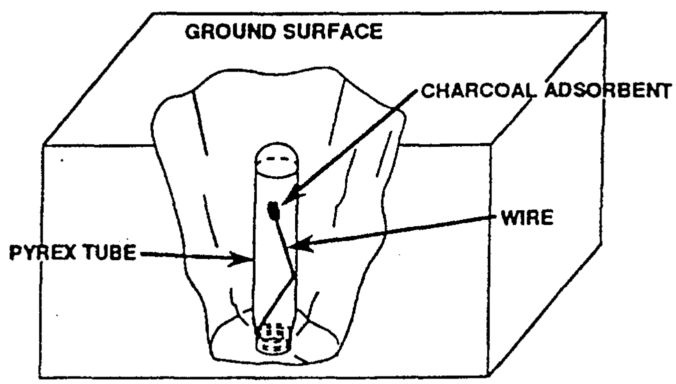
In step 2, staff attempts to identify all possible uses of the VOC(s) of concern. For example, is it used as solvent or refrigerant? Then they identify the type of businesses that would use the VOC(s). At this point staff does research using business directories, phone books, and county and city records to identify those facilities (potential sources) in the past and present that might use or have used the VOC(s) found in the well. This search for potential sources is done for an area approximately 1/2 mile in radius around the well. Some record searches for have gone as far back as the 1930's.

In step 3, inspecting possible sources, a questionnaire is first mailed to potential sources asking the facility operators about their uses of VOCs. This is the initial screening and reduces the quantity of field inspections. For example, if a facility is listed as a dry cleaner in the phone book and the questionnaire response says it is only a transfer station and no solvents are used, then the site would be removed from the potential source list and not inspected.

Staff inspects the facilities that use VOCs and determines if the potential source should be investigated further. If an investigation continues on a facility, then staff samples all discharges leaving the facility (discharges to land, water and sewer).

In step 4, identifying ground water characteristics, staff collects information from government and private ground water studies. The data collected from these studies are correlated to give a general understanding of the stratigraphy and ground water characteristics. This is not site-specific and is done after identifying possible sources so there is not a bias to upgradient sources.

In step 5, the soil gas survey is used to identify areas of VOCs in the soil and ground water. A survey involves placing glass tubes, each containing a carbon coated wire, open end down, 10-12 inches below the soil surface (Figure 3). After placement, the tubes are covered with soil. The evaporating VOC gasses disperse through the soils and reach the survey



SOIL GAS TUBE

Figure 3

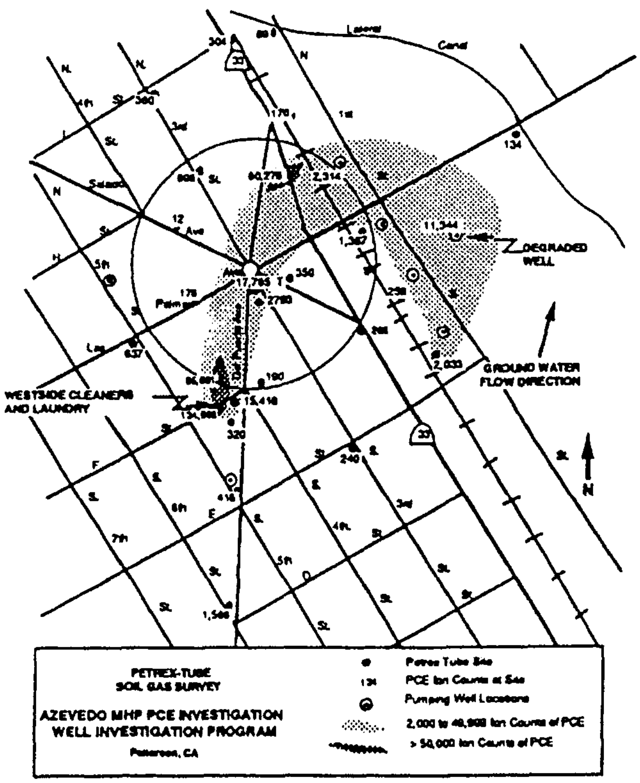


Figure 4

equipment. Approximately six week later, the tubes are removed and sent to the laboratory for VOC analysis. The results are in numbers of a specific VOC molecule retained by the carbon coated wire. The numbers are not concentrations, but are relative to each other. Locations with high counts have more of that VOC in the soil vapor than areas with low counts. Figure 4 is an example of the results of one of these surveys.

At this point the potential sources have been reduced to a few likely sources. It is at this time that site investigations are requested from the likely sources.

RESULTS OF PCE SOURCE INVESTIGATIONS

Staff source investigations have found that PCE is used in several industries (Figure 5) and is a component of several over-the-counter products such as brake and carburetor cleaners and spot removers. Staff surveys of industries other than dry cleaners which used these products show that PCE is not the main constituent in most of them. These products are usually less than 30% PCE, while dry cleaning solvent

IDENTIFIED SOLVENT USERS

- ***Auto/Boat Industry**
  - Service Stations
  - Auto Dealerships
  - Boat Dealerships
  - Truck Repairs
  - Auto Maintenance Facilities
- ***Telephone Companies**
- **Elevator Service Companies**
- **Public Schools**
- **Mobile Home Parks**
- ***Dry Cleaners**
- **Laundries**
- **Print Shops**
  - Newspapers
  - *Copying and Printing Businesses
- **Machine Shops**
  - Electric Motor Repair
  - Sheet Metal & Welding
- **Lumber/Timber Industry**
- ***Over-the-Counter Products**
- **Furniture**
  - Strippers
  - Antique Shops
  - Upholstery Repair
- **Power Stations**
- **Paint Dealers**

* - Industries where at least one product has PCE

Figure 5

is 100% PCE. Dry cleaning uses a large quantity of PCE solvent compared to other potential sources. The typical cleaner uses between 15 and 40 gallons a month of pure PCE. Many of the other industries also collect the solvent after use for recycling and do not discharge waste liquids to the land or sewer. Also, many of the solvents used that contain PCE are in aerosol cans. The solvent is sprayed on the part to remove grease and as the part dries, the PCE volatilizes into the air. Most industries other than dry cleaners which use solvents have no daily discharge of waste liquids containing PCE.

The staff soil gas surveys, which include all solvent users, show dry cleaners as the source areas. Figures 6 and 7 are two examples. None of the soil gas surveys have shown PCE vapor plumes near other solvent users.

Based on questionnaires, inspections, handling practices and soil gas surveys, staff concludes that dry cleaning is a major source of PCE ground water degradation in the Central Valley.

LODI

SEWER LINES

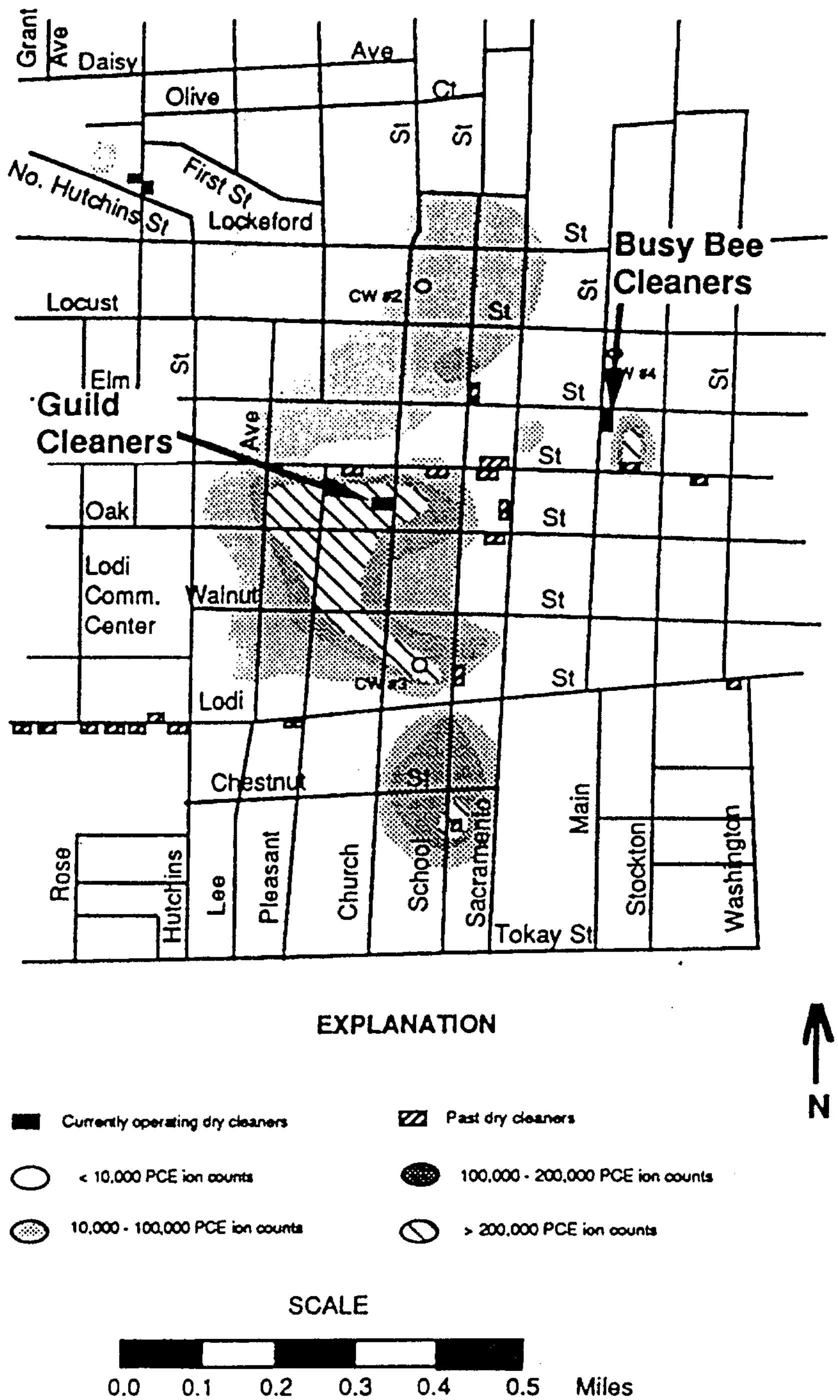


Figure 6

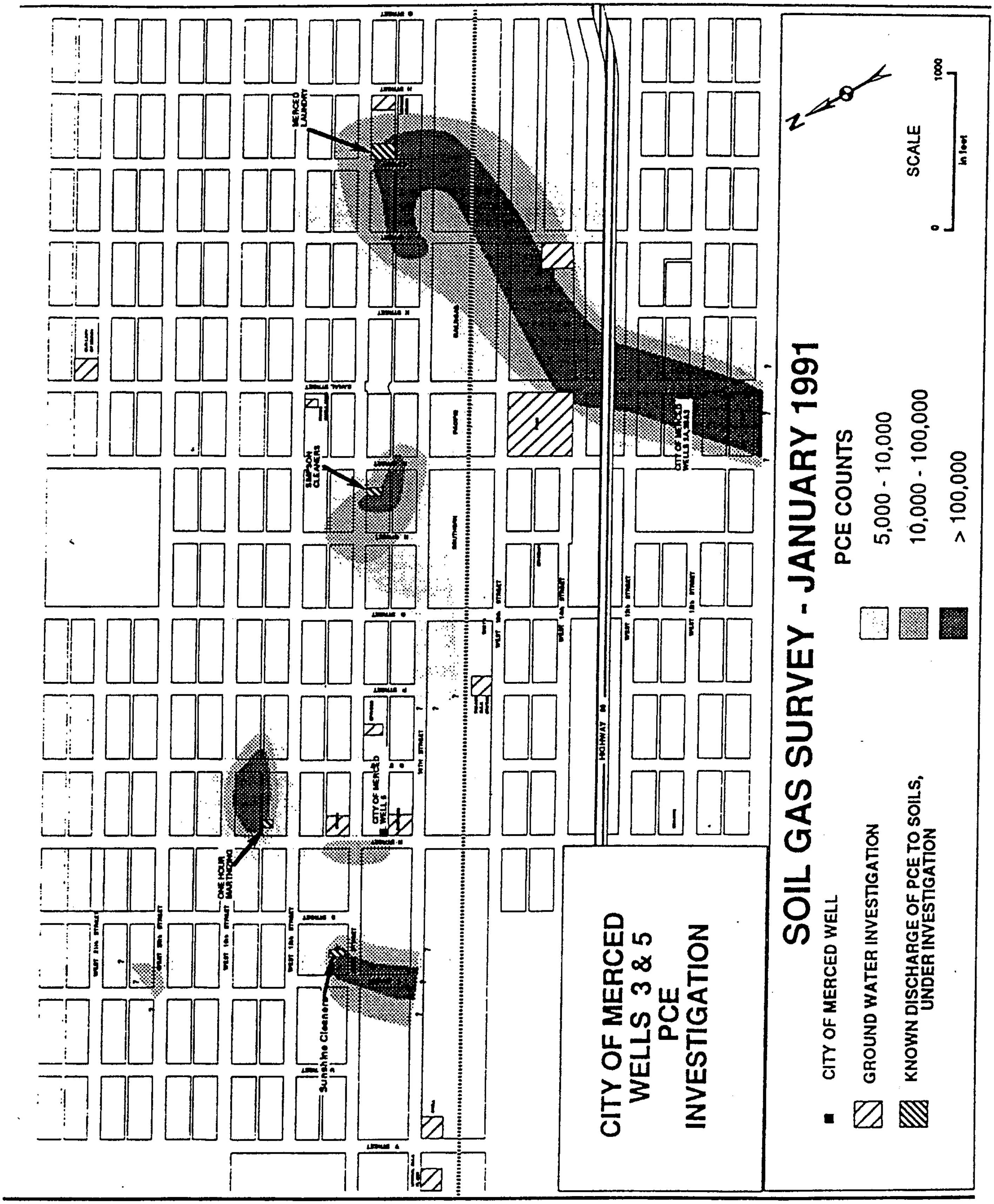

CITY OF MERCED
WELLS 3 & 5
PCE
INVESTIGATION
SOIL GAS SURVEY - JANUARY 1991
PCE COUNTS
5,000 - 10,000
10,000 - 100,000
> 100,000
CITY OF MERCED WELL
GROUND WATER INVESTIGATION
KNOWN DISCHARGE OF PCE TO SOILS, UNDER INVESTIGATION
SCALE
0
1000
in feet
MERCED LAUNDRY
SIMPSON CLEANERS
ONE HOUR MARTINIZING
Sunshine Cleaners
CITY OF MERCED WELL 5
HIGHWAY 99

Figure 7

DRY CLEANERS OPERATION AND DISCHARGE LOCATIONS

There are two basic types of dry cleaning machines, transfer and dry-to-dry. Both have similar types of discharges with the dry-to-dry machine being more efficient. The only major difference is that the dry-to-dry unit does the washing and drying of the clothing in the same machine, while a transfer unit use separate machines. The following section is a general description of a facility containing a transfer unit.

Dry cleaning transfer systems include a dry cleaning wash unit, PCE storage tank (generally part of the wash unit), reclaimer (dryer), cooker and vapor condenser (Figure 8). Pure PCE solvent is added directly from the PCE tank to the wash unit. A small amount of water and soap is usually added to remove stains that PCE will not. Most facilities send the spent solvent (after washing cycle) through solid filter canisters to remove solids and then return it to the PCE tank in a closed system. The solvent in the PCE tank also is periodically purified by physical transfer to the cooker, which separates solvent from solids through distillation and forms a sludge at the bottom.

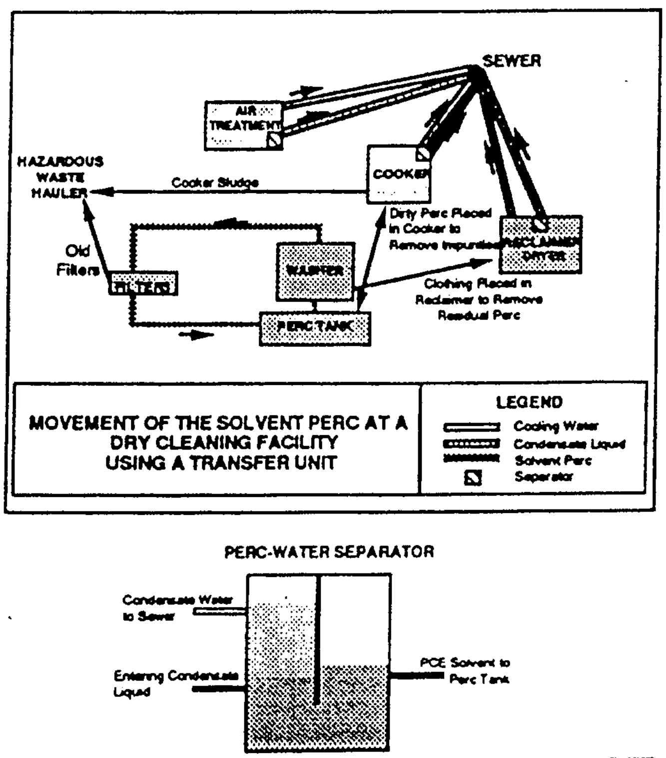


Figure 8

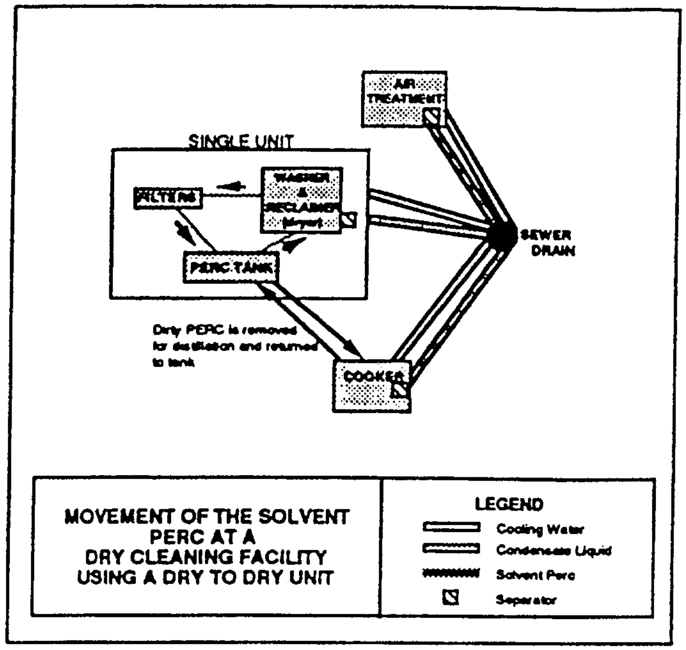
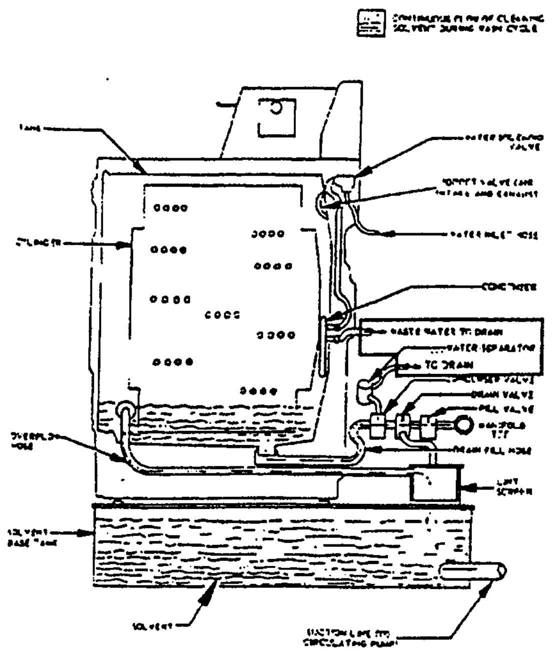


Figure 9

After washing, the clothing is removed from the wash unit and placed in the reclaimer to remove residual solvent. This drying process removes PCE solvent by heating the clothing which causes the solvent and any water to evaporate. The vaporized solvent and water is then removed from the drying portion of the machine and condensed. The PCE-water separator, which is connected to the back of the unit, takes the condensed liquid that contains PCE and water and allows the heavier PCE to settle to the bottom for reuse. The air scrubber (sniffer) extracts and cleans vapors from the other dry cleaning components and the air. These vapors also are condensed and the PCE and water separated.

In general, information provided by dry cleaner operators, inspections done by staff, and manufacturers' service manuals show that dry cleaning equipment is designed to discharge wastewater to the sewer. Figures 8 and 9 are schematics showing the two main types of wastewater discharges from dry cleaning equipment: liquid from the PCE-water separators and cooling water. Figure 10 is a schematic from one manufacturer's service manual that shows that wastewater should be discharged to the drain (11). This is typical of service manuals.



COIN-OP DRY TO DRY UNIT

Graphic From - Norge Sales Corporation, Service Instruction and Parts Catalog, 1961

Figure 10

The water from the PCE-water separators has been in direct contact with PCE. Water samples from separators at some cleaners have had such high concentrations of PCE that after the sample bottle sat for a day, solvent had separated out. As much as 30 percent of some samples has been pure solvent. PCE-water separator waste liquid has had PCE levels up to 1,119,300 ug/l (ppb), with an average of 151,800 ppb and median 64,000 ppb (Figure 11). Cooling water samples at dry cleaners have usually ranged from 3 to 70 ppb PCE, but some have been as high as 4,000 ppb (Figure 12).

EVIDENCE AND THEORY ON HOW PCE IS LEAVING THE SEWER LINES

Based on site inspections, the majority of the cleaners had only one discharge point and that was to the sewer. Because of these discharges, staff investigated sewer lines as a possible discharge point for PCE to the soils. Samples taken from these lines indicated that liquids or sludges with high concentrations of PCE are lying on the bottom of the sewer. Soil gas surveys

DRY CLEANERS SAMPLING RESULTS FROM CONDENSATE LIQUID

CLEANER	CITY	DATE	RESULT in ppb	UNIT
Busy Bee	Lodi	9/11/90	60,699	Reclaimer
Turlock Cleaners	Turlock	4/29/91	62,755	Cooker
Snow White	Turlock	1/26/89	140 56	Reclaimer Cooker
Durite Cleaners	Turlock	1/30/89	15,000 150,000	Sniffer & Reclaimer II Reclaimer I
Brite Cleaners	Turlock	5/11/89	66,000	Reclaimer
Southgate Norge	Sacramento	3/20/91	247,000	Sniffer & Reclaimer
Tillet Cleaners	Roseville	4/11/89	74,000	Reclaimer
Merced Laundry	Merced	11/29/88	130,000	Sniffer
Modesto Steam	Modesto	4/30/91	1,119,300 139,087 8,120 53,618	Reclaimer Cooker Chiller Recalimer
		Median	64,000	
		Average	151,800	

Figure 11

CONCENTRATION OF ORGANIC CHEMICALS IN COOLING WATER FROM DRY CLEANERS

DRY CLEANERS	CITY	DATE	RESULTS in ppb	
Busy Bee	Lodi	8/24/89	0.66 2.1 0.69	PCE TCE 1,1-DCE
		8/28/90	1.2 1	PCE TCE
DuRite	Turlock	11/29/91	6.3 4.7 1.7 5.3	PCE PCE PCE PCE
Turlock	Turlock	5/21/90	0.8 1.3	PCE PCE
Bright	Turlock	5/11/89	2.7	PCE
Tillet	Roseville	11/30/88	67 32	PCE Chloroform
		2/10/89	1.1 23	PCE Chloroform
Deluxe	Roseville	2/26/89	0.8 69	PCE Chloroform
Elwood's	Modesto	4/30/91	14	PCE
Parkway	Merced	9/8/88	69	PCE
Simpson	Merced	9/8/88	38	PCE
Southgate Norge	Sacramento	1/12/89	28	PCE
Merced Laundry	Merced	11/29/89	4000	PCE

Figure 12

done by staff and by private consultants illustrate high PCE vapor concentrations along the sewer lines. Work done by the City of Merced shows that intact sewer lines can and have discharged PCE to the soil.

Below are descriptions of sampling done and our interpretation of the data. Following these descriptions is a section on the theories of how PCE escapes from the sewer pipes.

SOIL GAS SURVEYS

Soil gas surveys related to PCE in ground water have been done by Board staff in Sacramento, Lodi, Merced, Modesto, Stockton, Roseville and Turlock. Every place PCE molecules have exceeded 100,000 counts and monitoring wells have been installed, PCE levels in ground water exceeded the MCL. In most cases, the PCE concentration in ground water has exceeded 300 ppb, which is 60 times the MCL. Thus, this survey technique has been very successful.

Figures 13 through 16 are maps showing results of soil gas surveys from Turlock, Modesto, Lodi and Merced which illustrate that PCE vapors are higher along the sewer lines. The highest counts are usually near the cleaners, but the counts continue high from the sites down the sewer line.

Around several dry cleaners near Stockton, a private consultant performed a soil vapor survey for PCE. The consultant extracted a volume of air from the soils

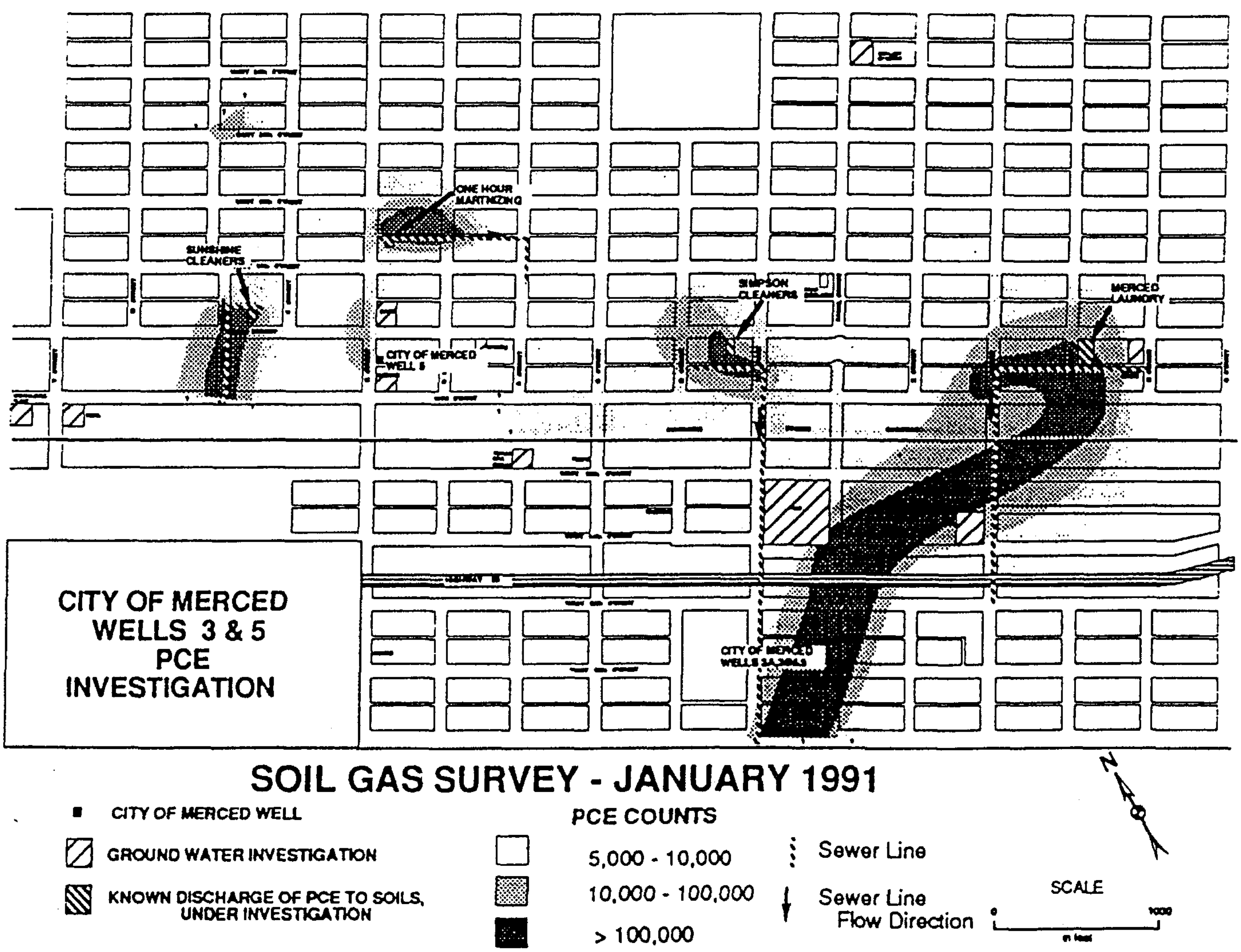


FIGURE 13

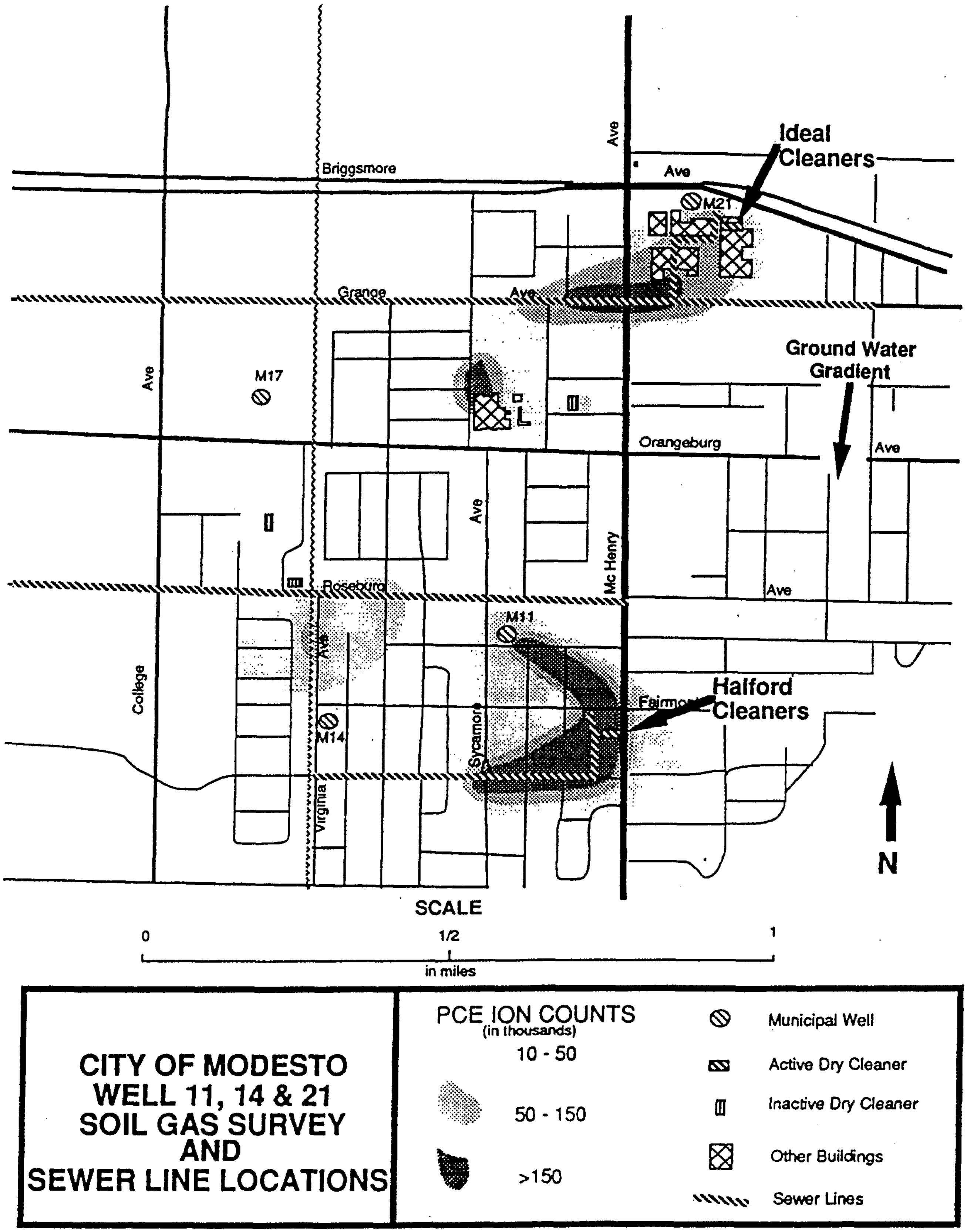
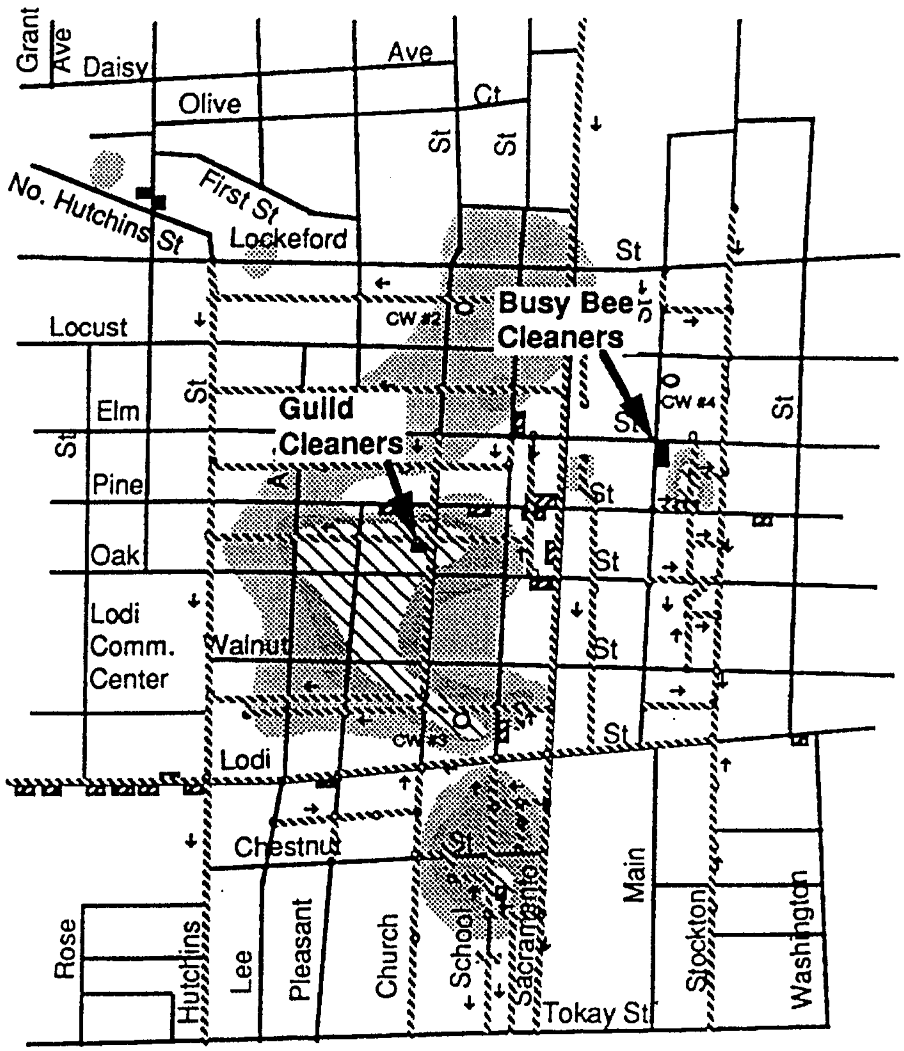

Ideal Cleaners
Briggsmore
Ave
Ave
M21
Grange
Ave
Ground Water Gradient
Ave
M17
Orangeburg
Ave
Ave
Mc Henry
Roseburg
Ave
M11
Ave
College
Halford Cleaners
M14
Sycamore
Virginia
N
SCALE
0
1/2
1
in miles
CITY OF MODESTO
WELL 11, 14 & 21
SOIL GAS SURVEY
AND
SEWER LINE LOCATIONS
PCE ION COUNTS
(in thousands)
10 - 50
50 - 150
>150
Municipal Well
Active Dry Cleaner
Inactive Dry Cleaner
Other Buildings
Sewer Lines

Figure 14

LODI

SEWER LINES



EXPLANATION

N

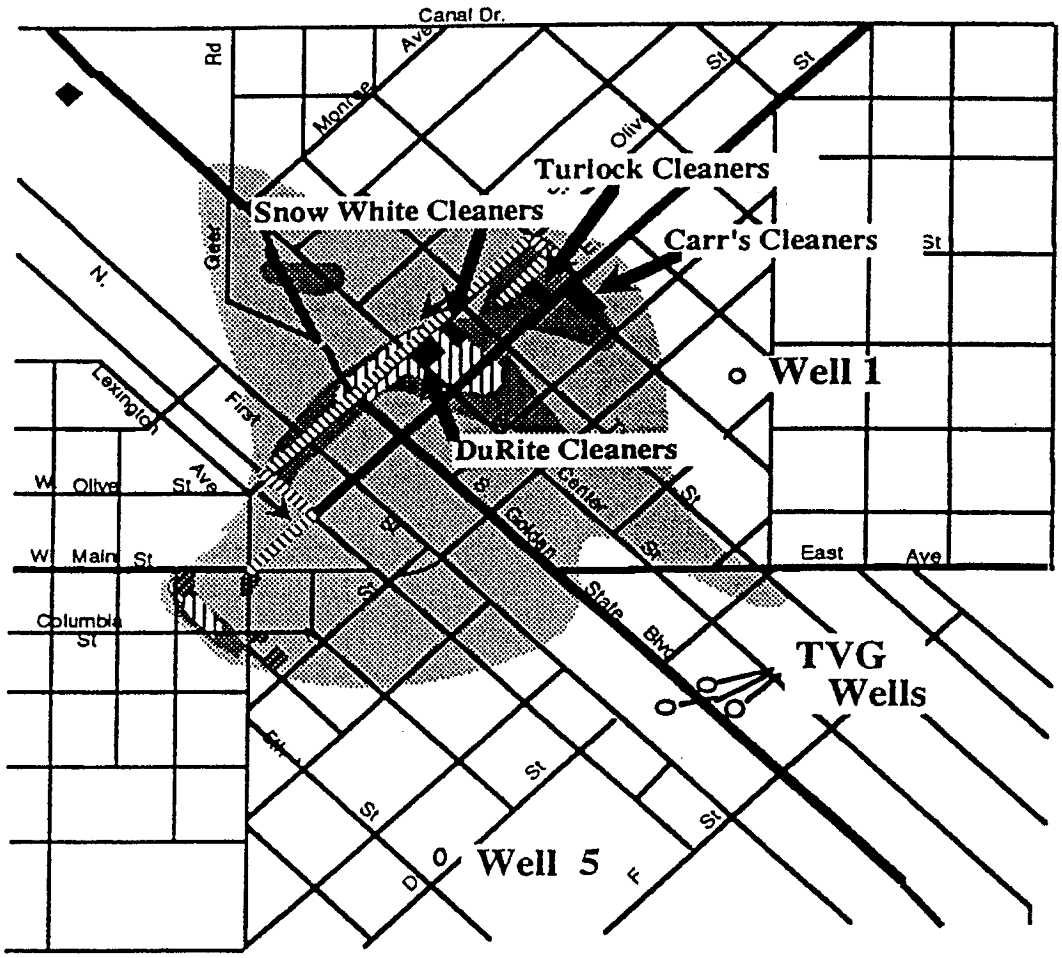
- Currently operating dry cleaners
- Past dry cleaners
- < 10,000 PCE ion counts
- 100,000 - 200,000 PCE ion counts
- 10,000 - 100,000 PCE ion counts
- > 200,000 PCE ion counts
- Sewer lines
- Sewer line flow direction

SCALE

0.0 0.1 0.2 0.3 0.4 0.5 Miles

Figure 15

TURLOCK SOIL GAS SURVEY



◆ ACTIVE DRY CLEANER

INACTIVE DRY CLEANER

o WELL

SEWER LINE

10,000-100,000 PCE ION COUNT

100,000-200,000 PCE ION COUNT

>200,000 PCE ION COUNT

0 SCALE 1/2

MILES

N

Figure 16

and ran the sample through a gas chromatograph. This survey also indicates high concentrations of PCE vapor along the sewer line (Figure 17). There are similar surveys done by other private consultants with the same results.

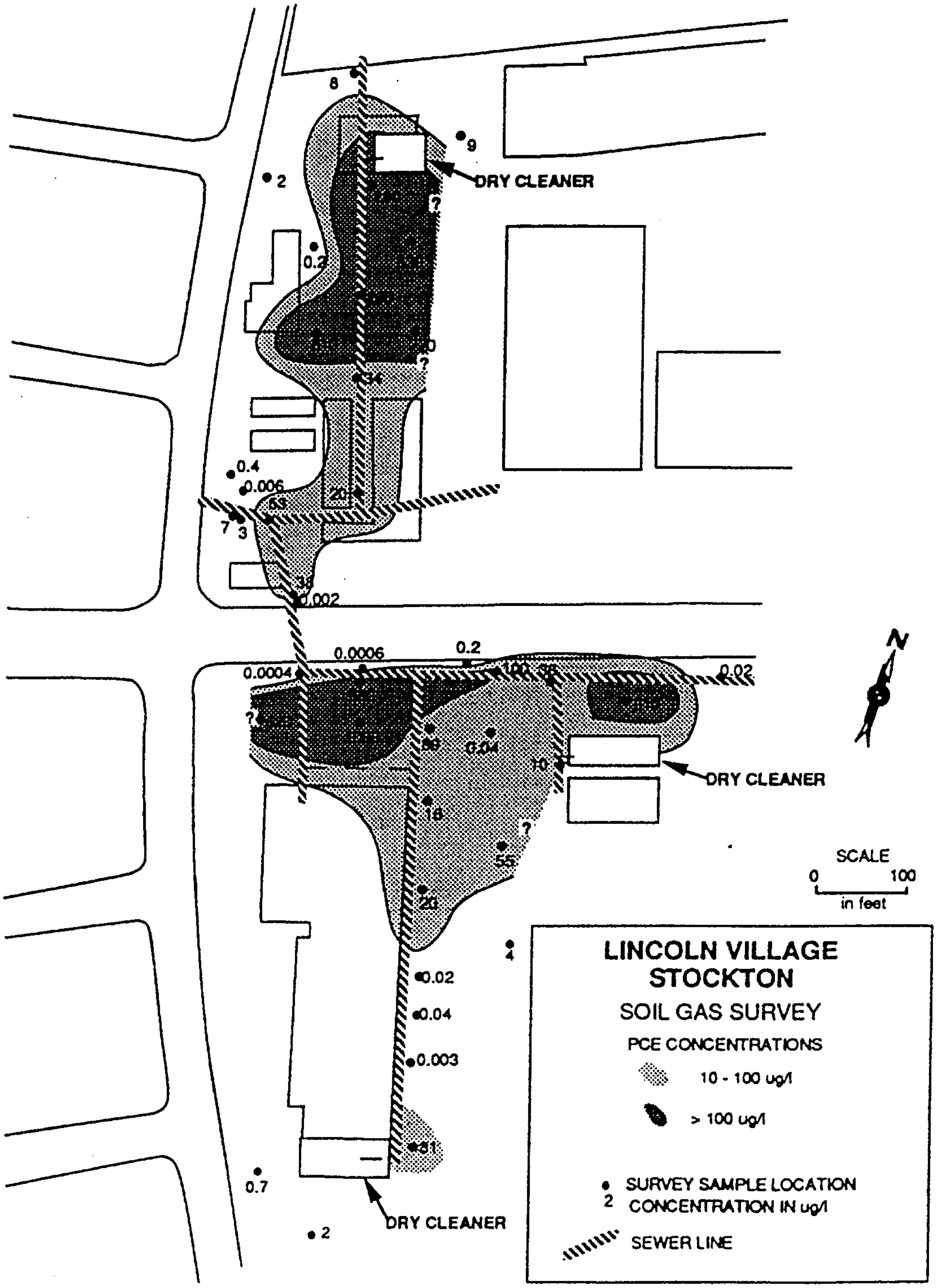


Figure 17

SEWER MAIN SAMPLING

Three samples are usually taken from the sewer: an upgradient, a downgradient and a flush sample. The upgradient (background) and downgradient samples are taken at the sewer access just above and below where the dry cleaner's sewer lateral enters the main (Figure 18). All samples are taken by placing a jar on a pole and scooping liquid into the jar. The liquid is then poured into volatile organic analysis (VOA) bottles and sent to a California certified lab for analysis. The flush sample is taken after stirring up the bottom sediment by adding large quantities of water (and sometimes running a ball down the line). The flush sample is taken at the downgradient sewer access, when an increase of flow is noted (Figure 18).

The concentration of PCE in the downgradient sample has always exceeded that in the upgradient sample, and in most cases PCE in the upgradient sample was not detected. When flush samples were taken, their PCE content almost always exceeded that in the downgradient sample. Since water is being added to the system, one would expect the PCE concentration to decrease in the flush sample because of dilution. Therefore, the increase indicates that PCE liquids or sludges are sitting on the bottom of the sewer line.

SEWER SAMPLING ADJACENT TO DRY CLEANERS

	Upgradient in ppb	Downgradient in ppb	Flush in ppb
MERCED			
Merced Laundry	-	180	-
One Hour Martinizing "R"	NF	110	23,000
One Hour Martinizing "G"	NF	730	96,000
Simpson Cleaners	-	-	6,300
Sunshine Cleaners	NF	-	167,000
Parkway Cleaners	NF	853	280,000
SACRAMENTO			
Southgate Norge Cleaners	NF	350	830
ROSEVILLE			
Deluxe Cleaners	-	120	260
Tillets Cleaners	NF	28	380
TURLOCK			
Carr's Cleaners	<0.5	14	2.5
Snow White Cleaners	1,800	3,800	220
Turlock Cleaners	NF	3,500	<25
Bright Cleaners	<0.5	0.6	23,000
Durite Cleaners	35	190	<5
LODI			
Busy Bee	NF	700	280,000
Woodlake Cleaners	-	620	210,000
Guild Cleaners	<0.5	24	<5
	Median	190	3,565
	Average	748	67,937

NF - NO FLOW

Figure 18

CITY OF MERCED

Between 12 January and 2 February 1989, the City of Merced conducted soil sampling near four dry cleaners. The City staff did a video scan of the sewer lines at each of the cleaners to check for possible leaks. After these scans, they drilled a soil boring adjacent to the sewer line downgradient of each facility where a problem was seen on the video tape. If the tape showed no problem, they drilled adjacent to the sewer line near the dry cleaner. In each boring they took several soil samples and had them analyzed for VOCs by EPA Method 8010. They also took soil vapor measurements using a Sensidyne-Gastec system (similar to Draeger tubes) with a detection limit of 400 ppb.

In addition to the City's work, each dry cleaning facility had a monitoring well (MW) drilled as required by staff. Soil samples were taken every five feet during drilling and analyzed for VOCs using EPA Method 8010. One ground water sample was taken from each well and analyzed for VOCs using EPA Method 601.

Parkway Cleaners

Figure 19 contains the data from the Parkway Cleaners site. The MW was drilled approximately 22 feet from Parkway's sewer lateral and 15 feet from the sewer main. Soil samples from the well boring had low levels of PCE (<5 ppb). The concentration of PCE in the ground water was 160 ppb.

The City's video scan of the sewer main showed no breaks in the clay pipe. Because of this, the City arbitrarily selected a soil boring site adjacent to the sewer line, six feet downgradient from Parkway Cleaners' sewer lateral. The PCE concentration in the soil sample in the City soil boring was 120 times

PARKWAY CLEANERS
MERCED

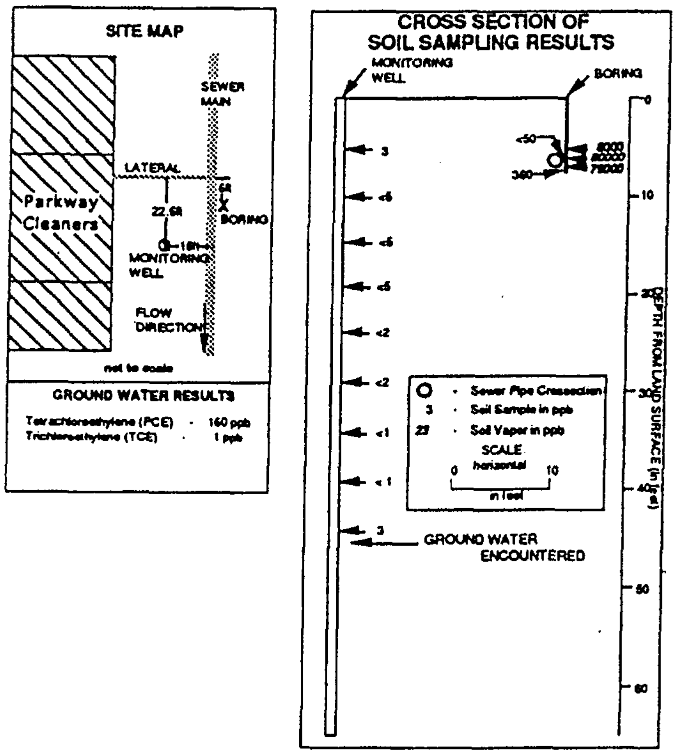


Figure 19

higher than was found in the MW. Also, soil vapor samples in the City boring contained up to 80,000 ppb PCE.

At this location the levels in the soil are much higher adjacent to the sewer line than in the MW. Also the data from the sampling adjacent to the sewer line indicate that PCE has moved from the line into the adjacent soils.

Simpson's Cleaners

Figure 20 illustrates the data from the Simpson's Cleaners site. Soil samples taken during the drilling of the MW at the southwest corner of the facility had PCE levels from non-detect to 71 ppb. The shallow ground water sample had 270 ppb PCE and also contained 29 ppb trichloroethylene (TCE), 65 ppb cis-1,2dichloroethene (DCE), two ppb trans-1,2-DCE, and 6 ppb 1,2-dichloroethane, all of which are breakdown

SIMPSON'S CLEANERS
MERCED

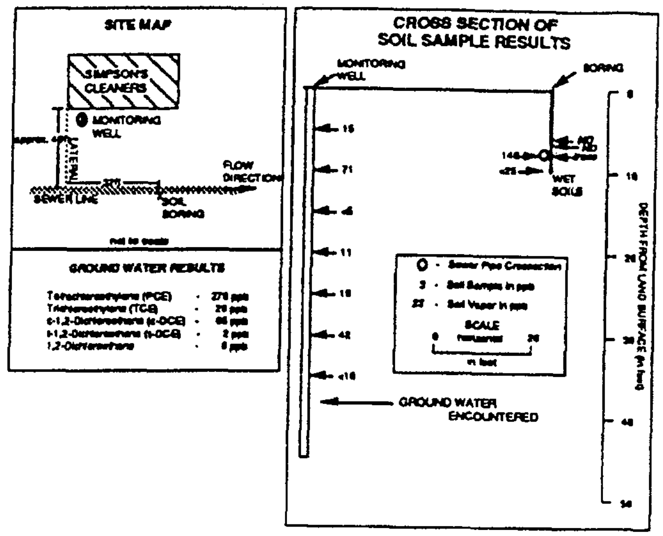


Figure 20

products of PCE. The MCL for TCE is 5 ppb and for DCE is 6 ppb.

The City's video scan of the clay sewer main adjacent to the cleaners showed a break at one of the joints. This break is approximately 40 feet downstream along the sewer line from the southeast corner of Simpson's Cleaners. While drilling alongside this joint the soil became very wet. One of the soil samples had 140 ppb PCE, higher than samples taken from the MW boring. The soil gas measurement readings were non-detect.

Again the soil sample adjacent to the sewer line contained higher PCE levels than samples taken from the MW boring. One probable reason the soil gas measurements were non-detect at the joint was the soils were very wet, which means the soil pores were probably full of water leaving no available room for the soil vapor.

Sunshine Cleaners

Figure 21 contains the data from the Sunshine Cleaners site. The MW was drilled near the northeast corner of the cleaners, 9.5 feet from its sewer lateral. The soil samples from the MW had PCE concentrations up to

SUNSHINE CLEANERS

MERCED

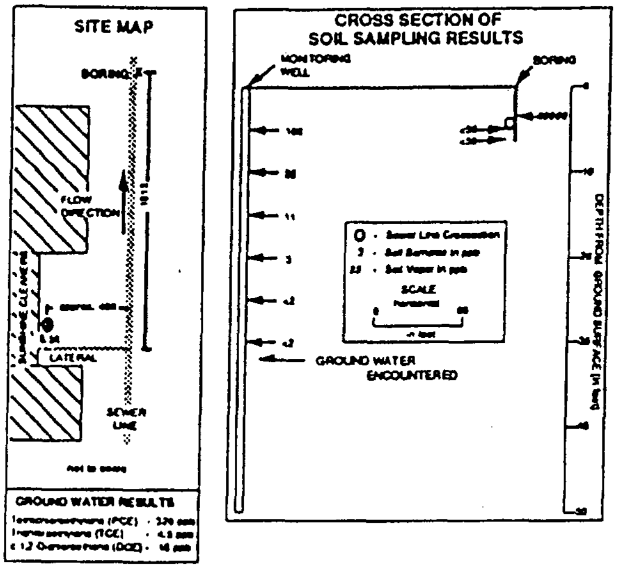


Figure 21

100 ppb. The ground water sample had 320 ppb PCE, 4.5 ppb TCE and 18 ppb DCE.

The City's video scan of the sewer line showed no breaks in the concrete sewer main. The City personnel chose a sag in the sewer main where the water pools for the location of the adjacent soil boring. This site was 181 feet downgradient of the cleaner's sewer lateral. PCE in the soil samples was nondetect, but the detection limit was high at 50 ppb. The Sensidyne-Gastec vapor system had a reading of 40,000 ppb in the boring.

The high levels detected by the Sensidyne-Gastec system indicates even at a distance of 181 feet downgradient from the dry cleaner, the concentration of PCE in the soil gas is significant. No comparison of soil samples between the MW and City's soil boring can be made because of the high detection limit from the City's samples.

One Hour Martinizing "R" Street

Figure 22 shows the data from the One Hour Martinizing "R" Street site. The MW was drilled eight feet northwest of the sewer line approximately 16 feet

ONE HOUR MARTNIZING

R STREET, MERCED

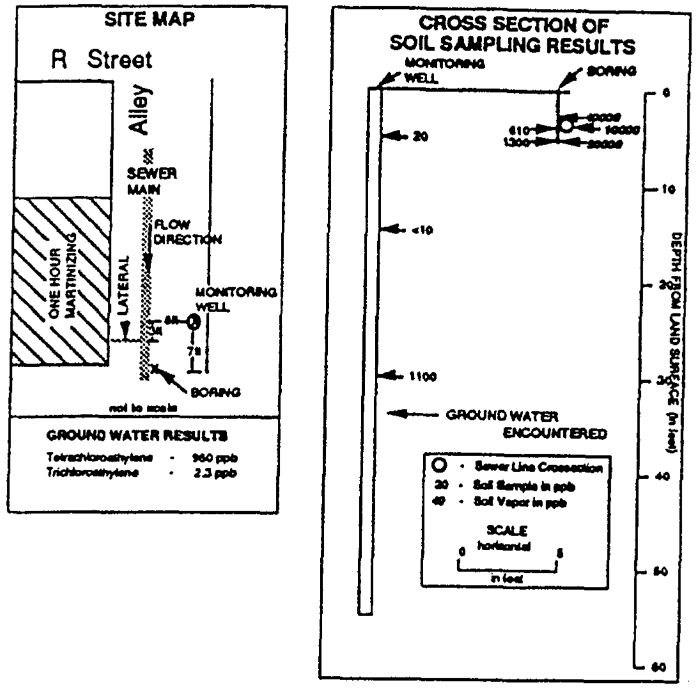


Figure 22

from the cleaner's northwest wall. PCE levels in the soil samples taken during drilling of the MW were low in the upper 20 feet ranging from nondetect to 20 ppb, but near the ground water a soil sample had 1,100 ppb PCE. The ground water sample had PCE and TCE with concentrations of 960 ppb and 2.3 ppb, respectively.

The City's video scan of the clay sewer line showed no breaks. The City personnel decided to drill adjacent to a bell joint four feet downgradient from where the cleaner's sewer lateral intersects the sewer main. Soil samples in this boring had PCE at 610 ppb (depth 46") and 1,300 ppb (depth 63"). The City took three Sensidyne-Gastec system measurements at the following depths from the surface: 36" (above the main), 46" (bottom side of pipe) and 63" (below the main), and the readings were 40,000 ppb, 10,000 ppb and 20,000 ppb, respectively.

Along the sewer main, the soil gas measurements and the soil samples had high levels of PCE, indicating that at this location the sewer main is discharging PCE.

THEORIES ON HOW PCE LEAKS FROM SEWER LINES

Based on staff field work and research, there are five likely methods by which PCE can penetrate the sewer line:

1. Through breaks or cracks in the sewer pipes
2. Through pipe joints and other connections
3. By leaching in liquid form directly through sewer lines into the vadose zone
4. By saturating the bottom of the sewer pipe with a high concentration of PCE-containing liquid and then PCE volatilizing from the outer edge of the pipe into the soils
5. By penetrating the sewer pipe as a gas

The literature indicates that all sewer lines leak to some extent. According to Metcalf and Eddy, Inc., "When designing for presently unsewered areas or relief of overtaxed existing sewers, allowance must be made for unavoidable infiltration..." (6). If the soils become saturated and liquids can infiltrate, then a conclusion can be made that liquids on the inside of the pipe can exfiltrate when soils are not saturated.

Below is a brief description of the five methods.

Methods 1 and 2

Methods 1 and 2 are similar in that leakage of liquid is caused by a failure of the sewer pipe system. The failure could be catastrophic, causing large volumes of liquids to leave the system, or could consist of many small leaks causing constant smaller flow. These discharged liquids then would move down through the vadose zone to the ground water. Methods 1 and 2 also apply to PCE in vapor form which can move easily through breaks, cracks, joints, and other connections.

Many of the sewer lines have low spots in which liquids accumulate. These low spots are caused by settlement or poor construction which causes the sewer line to bend. Sewer pipes are brittle, so when the line bends, fractures are likely to occur, increasing the leakage of the pipe. Since PCE is heavier than water (1.63 times the weight of water at 20°C), it tends to collect in these low spots and then flow through the pipe fractures into the vadose zone.

At pipe joints and other connections, PCE can move out of the sewer as liquid or gas. Also, as the pipes shift after installation, they could separate at the joints, allowing PCE to discharge even more easily to the vadose zone. Current gasket technology and reduction in leakage factors of pipes by the industry has reduced discharges at this point. But most commercial and retail districts in the cities of the Central Valley have pipes that predate this technology.

Method 3

By this method, PCE-containing wastewater or PCE liquid penetrates a sewer pipe without any breaks. In this case liquid leaves the pipe and enters the vadose zone (Figure 23). Sewer pipe is not impermeable to water or PCE. When liquid collects in a low spot of the sewer pipe, it cause an increase in the hydraulic head in the line. This extra head provides a larger driving force downward through the pipe.

From sewer sampling we know that PCE-containing sludges and/or liquids collect on the bottom of the sewer line. Video taping of sewer mains have shown that almost all lines have low points where liquids and sludges collect. Because PCE is heavier than water and is attracted to organic matter, it would have a tendency to collect in these low spots. Also, PCE viscosity is less than that of water (0.9 for PCE versus 1 for water), making it flow easier through a pipe wall than water. This makes the pipe more permeable for PCE.

Method 4

This is similar to Method 3 except that the hydraulic head in the pipe is not large enough to force liquid

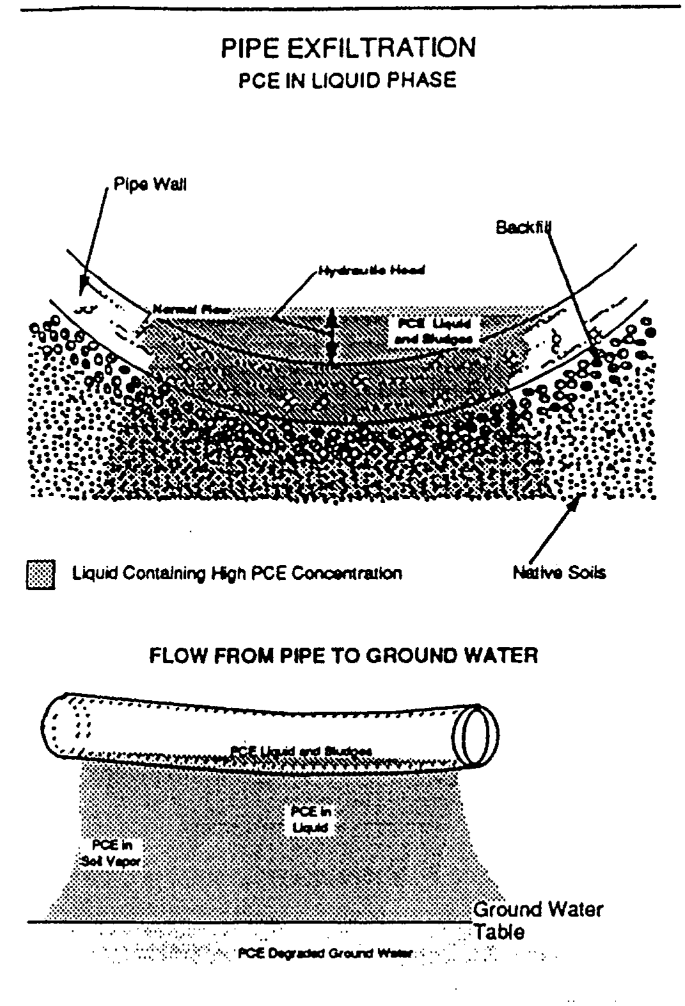


Figure 23

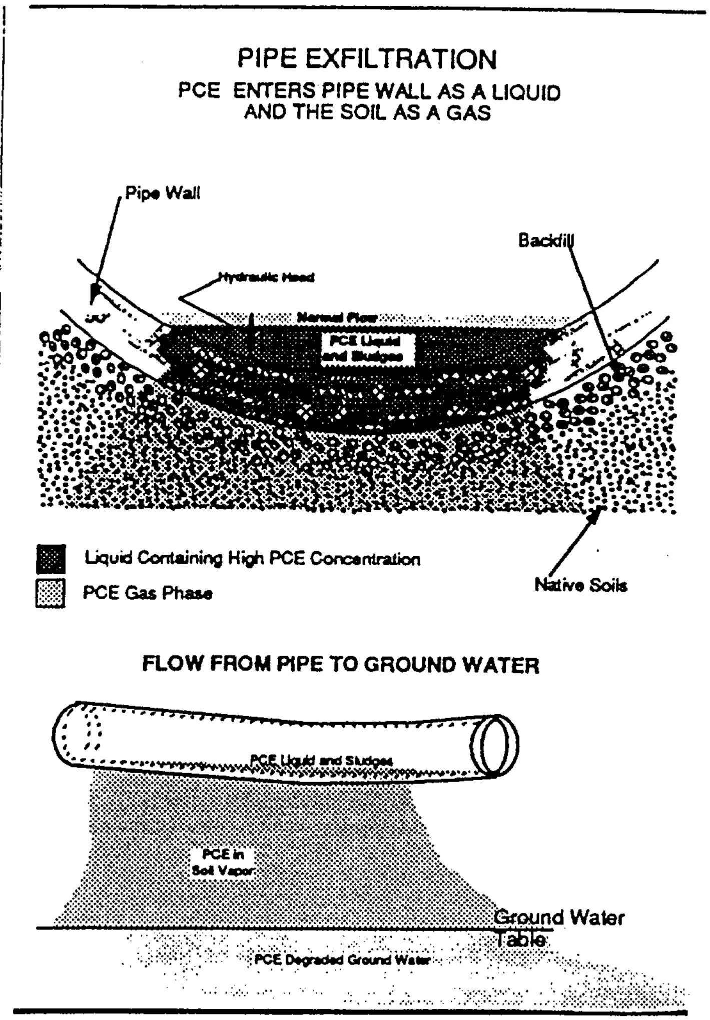


Figure 24

into the vadose zone. In this method, the pipe walls still have a high concentration of PCE-containing liquids (Figure 24). Being volatile, PCE turns into a gas at the liquid-soil vapor interface at the outer edge of the pipe. Since the vapor density of PCE is 5.83 times greater than air, the PCE gas in soil vapor would sink towards ground water, causing ground water degradation.

Method 5

In this method, PCE volatilizes inside the pipe and moves as a gas through the sewer pipe wall (Figure 25). The piping material is not designed to contain gas. The concentration of PCE gas in the pipe is greater than in the surrounding soils causing a concentration gradient. This causes a dispersion through the sewer pipe to the less concentrated area.

Another reason gas will penetrate the pipe is due to pressure. The gasses inside the pipe may increase the pressure above atmospheric. This would cause a pressure gradient from higher pressure in the pipe to lower pressure in the vadose zone. The gradient would force PCE gas into the vadose zone. As described above, PCE gas is heavier than air and so would tend to sink towards ground water.

Summary of Methods

Methods 3, 4 and 5 probably occur in all piping. They would cause a constant influx of PCE into the vadose zone downgradient from a dry cleaner. This liquid containing PCE or PCE in gas form then moves downward and eventually degrades the ground water.

PCE PENETRATES A PIPE AS A GAS

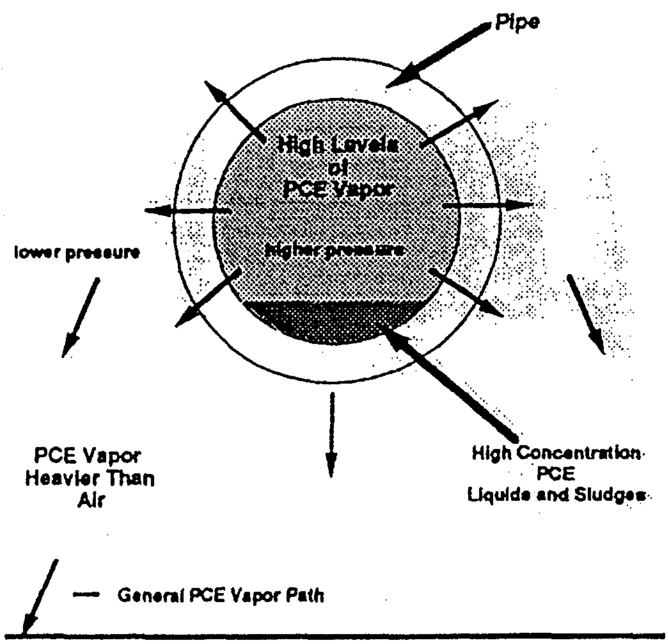


Figure 25

Leakage through small fractures in Method 1 is likely in most of these brittle pipes as they settle. Small fractures occur causing an increase in the permeability of the pipe. This would cause a constant leakage. These small fractures cannot be seen by video taping the inside of the sewer pipe.

CONCLUSION AND RECOMMENDATION

The Board has identified the potential sources of PCE in 21 wells, and 20 of those are affected by one or more dry cleaners. Because of the location of the remaining wells (i.e. in residential and retail areas), the staff expects that the majority of the wells with PCE will have dry cleaners as the source.

The evidence from five years of investigations shows PCE has been found in the ground water and vadose zone near dry cleaners throughout the Central Valley. In most dry cleaners, the only liquid discharge of PCE-containing wastewater is to the sewer line. The substantial evidence collected by dry cleaners' consultants, muncipalities, and staff, shows or demonstrates that PCE has discharged from the sewer lines directly into the vadose zone. The PCE then migrates through the unsaturated subsurface to the ground water. Based on information collected from operators of dry cleaners, dry cleaning literature and staff site inspections, the dry cleaning equipment at most facilities is designed to discharge to sewer lines.

Presently, all the dry cleaners investigated in a well source investigation have been identified as sources of PCE in the ground water. All of the dry cleaners that have drilled monitoring wells have had shallow ground water contamination well above the MCL of 5 ppb set by the State Department of Health Services (monitoring well levels range from 120 - 32,000 ppb). With approximately 285 dry cleaners in the cities of Sacramento, Chico, Lodi, Modesto, Turlock, Stockton and Merced, and numerous more in other cities, staff expects that many more wells will be degraded by PCE in the future.

In conclusion, the PCE discharges from dry cleaners to sewer laterals, then to sewer systems and then to soils have caused soil and ground water degradation.

Two major issues need to be resolved on the dry cleaners' PCE discharges:

1. Who should define the extent of ground water degradation and do the cleanup?

2. How do we prevent further degradation of the ground water by dry cleaners?

Ground water cleanup is required so that water supply agencies can continue to provide safe water. Deciding who should investigate and cleanup ground water is a complex political/legal issue since the PCE discharges from the dry cleaners were all approved, standard practice and those from the sewers were unsuspected. Because most dry cleaners are small businesses, which may not have the financial capability to define the contamination plume and conduct cleanup, other resources may be needed. A statewide cleanup fund may be appropiate. If no one else cleans up the ground water, water supply agencies will have to do it by default.

To prevent further degradation, the most obvious solutions are to set a limit for PCE discharge levels to the sewer line that will protect ground water or to disallow all future discharges to the sewers from dry cleaning. Two possible ways to accomplish this:

1. State legislation to set limits or prohibit discharge of PCE from dry cleaning facilities to sewer systems.

2. City ordinances to set limits or prohibit any discharge of PCE from a dry cleaning facility to the sewer line.

Since dry cleaners exist throughout the state a state-wide policies are needed.

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APPENDIX T

NEGOTIATED SEWER SERVICE CONTRACT

HM:kb

Contract No. N62474-71-C-3711

JOHN B. SHALLC

JUN 09 1972

DEPARTMENT OF THE NAVY
NEGOTIATED SEWER SERVICE CONTRACT

Marine Corps Air Station El Toro,	Santa Ana	California
(Premises to be served)	(City)	(State)

Irvine Ranch Water District	P.O. Box D-1 Irvine, California 92664
(Contractor)	(Contractor's Address)

Premises are: (x) Government Owned
( ) Government Leased
Symbol No. of Lease:
Name of Lessor:

Estimated annual cost hereunder: $45,000 (@ $225 per MG) 7 mo.
Connection Charge: Non-Refundable, Non-Recurring $1,000,000
Special Facilities Charge: Non-Refundable, Non-Recurring $236,760
Bills will be rendered in quintuplicate to:
Commanding General
Marine Corps Air Station
El Toro, Santa Ana, California

Payments will be made by: Navy Regional Finance Center
San Diego, California

Communications: All communications and modifications regarding this contract shall be addressed as follows:

Contractor: Irvine Ranch Water District
P.O. Box D-1
Irvine, California 92664

Government: Commanding Officer, Western Division (Code 113)
Naval Facilities Engineering Command
P.O. Box 727, San Bruno, California 94066

This contract is negotiated pursuant to the authority of 10 USC 2304 (a) (10)

Appropriations chargeable:
For Recurring Billing Charges: Applicable funds will be cited on invoices or delivery orders issued against this Contract.

For Connection Charge:

☐ NFC Cleveland ☐ WESTDIV 113 ☐ NRFC San
☒ CONTRACTOR ☐ NAVFAC (0212) ☐ ACTIVITY:

DUPLICATE ORIGINAL

HM:kb

Contract No. N62474-71-C-3711

THIS CONTRACT is entered into as of 1972 JUN 05 by and between the UNITED STATES OF AMERICA, hereinafter called the Government, represented by the Contracting Officer executing this contract and the Irvine Ranch Water District hereinafter called the Contractor.

I. SCOPE. Subject to the terms and conditions hereinafter set forth, the Contractor shall sell and deliver to the Government and the Government shall purchase and receive from the Contractor sewer service (hereinafter called service) requested by the Government from the Contractor at the premises to be served hereunder (hereinafter called the service location), in accordance with the General and Technical provisions and the Sewer Service Specifications attached hereto and made a part hereof.

II. TERM. This contract shall continue in effect for a period of thirty (30) years from the effective date hereof, unless terminated at the option of the Government by the giving of written notice not less than 60 days in advance of the effective date of termination.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

IRVINE RANCH WATER DISTRICT

BY ____________________
(President)

BY ____________________
(Secretary)

THE UNITED STATES OF AMERICA

BY ____________________
R. H. NELSON, Captain, CEC, USN
for Commander, Naval Facilities Engineering Command, Contracting Officer

HM:kb

Attached to and made a part of
Contract No. N62474-71-C-3711

TECHNICAL AND GENERAL PROVISIONS FOR UTILITY SERVICE

I. TECHNICAL PROVISIONS

1. MEASUREMENT OF SERVICE

(a) All service furnished by the Contractor shall be measured by metering equipment of standard manufacture, furnished, and installed, at Government expense, and maintained, calibrated, and read by the Contractor at his expense. When more than a single meter is installed at the service location, the readings thereof shall be billed conjunctively. In the event that any meter fails to register or registers incorrectly, the quantity of service delivered through it during that period shall be determined and an equitable adjustment based thereon shall be made in the Government's bills (for this purpose any meter which registers not more than two (2) percent slow or fast shall be deemed correct). Failure to agree on any adjustment shall be a dispute concerning a question of fact within the meaning of the "Disputes" clause of this contract.

(b) The Contractor shall read all meters at periodic intervals of approximately thirty (30) days. All billings based on meter readings of less than twenty-seven (27) days or more than thirty-two (32) days shall be prorated accordingly.

2. METER TEST. The Contractor, at his expense, shall periodically inspect and test the meters installed by him, at intervals of no longer than one (1) year. At the written request of the Contracting Officer, the Contractor, in the presence of Government representatives, shall make additional tests of any or all meters. The cost of such additional tests shall be borne by the Government if the percentage of error is found to be not more than two (2) percent slow or fast. No meter shall be placed in service which on test registers in excess of one hundred (100) percent under normal operating conditions.

II. GENERAL PROVISIONS

1. PAYMENT

(a) The Contractor shall be paid by the designated disbursing officer for service furnished hereunder at the rates specified; provided, that the Government shall be liable for the minimum monthly charge specified in this contract commencing with the billing period in which service is initially furnished and continuing until this contract is terminated, except that the minimum monthly charge shall be equitably prorated for the billing period in which commencement and termination of this contract shall become effective.

TECHNICAL AND GENERAL PROVISIONS FOR UTILITY SERVICE (Cont'd)

(b) Payments hereunder shall be contingent upon the availability of appropriations therefor, and shall not be made in advance of the service rendered.

(c) All bills for service shall be paid without penalty or interest and the Government shall be entitled to any discounts customarily applicable to payment of bills by all customers of the Contractor.

(d) Invoices for service rendered hereunder shall contain statements of the meter readings at the beginning of the billing period, meter constants, consumption during the billing period, and such other pertinent data as shall be required by the Government.

(e) The Contractor hereby declares that rates are not in excess of the lowest rates now available to any existing or prospective customer under like conditions of service, and agrees that during the life of this contract the Government shall continue to be billed at the lowest available rate for similar conditions of service.

2. RATES AND CHARGES

(a) For all service furnished under this contract to the service location the Government shall pay the Contractor at the rates specified in the rate schedule attached hereto and made a part of this contract.

(b) For purposes of charges under this paragraph 2, any demands due to faulty operation of, or to excessive or fluctuating pressure on, the Contractor's system shall not be included as part of the Government's demand.

TECHNICAL AND GENERAL PROVISIONS FOR UTILITY SERVICE (Cont'd)

3. PUBLIC REGULATION AND CHANGE OF RATES

(a) Public Regulation. Service furnished under this contract shall be subject to regulation—in the manner and to the extent prescribed by law—by any Federal, State or local regulatory commission have jurisdiction over the environmental aspects of sewage treatment, reclamation or disposal of sewage effluent. In the event that any Federal, state, regional or local regulatory body or agency having jurisdiction of Contractor hereafter requires additional facilities not now required for treatment, reclamation, or disposal of sewage or waste water, or a relocation of existing facilities, or in the event the Grantor of right of way requires such, then in such event Government shall participate on a proportionate basis in the cost of any relocation or additional facilities required by any such Federal, state, regulatory body, agency or Grantor.

(b) Change of Rates.
If, during the term of this contract, the load conditions change to the extent that the proportionate use of the facilities requires an adjustment of the rates specified in the rate schedule attached hereto and made a part hereof, then such change in rates shall be made by mutual agreement by the parties hereto.

4. CHANGE IN VOLUME OR CHARACTER OF SERVICE. The Contracting Officer shall give reasonable notice to the Contractor respecting any material changes anticipated in the volume or characteristics of the utility service required at each location within the limits prescribed by the Sewerage Service specifications and Exhibit "B".

5. CONTINUITY OF SERVICE AND CONSUMPTION

(a) The Contractor shall use reasonable diligence to provide a regular and uninterrupted supply of service at the service location, but shall not be liable to the Government for damages, breach of contract, or otherwise, for failure, suspension, diminution, or other variations of service occasioned by any cause beyond the control and without the fault or negligence of the Contractor. Such causes may include, but are not restricted to, acts of God or of the public enemy, acts of the Government in either its sovereign or contractual capacity, fires, floods, epidemics, quarantine restrictions, strikes, or failure or breakdown of transmission or other facilities; provided, that when any failure, suspension, diminution, or variation of service shall aggregate more than 10 hours during any billing period hereunder, an equitable adjustment shall be made in the monthly rates specified in this contract.

TECHNICAL AND GENERAL PROVISIONS FOR UTILITY SERVICE (Cont'd)

(b) In the event the Government is unable to operate the service location in whole or in part for any cause beyond its control and without its fault or negligence, including but not limited to acts of God or of the public enemy, fires, floods, epidemics, quarantine restrictions, or strikes, an equitable adjustment shall be made in the monthly rates specified in this contract if the period during which the Government is unable to operate the service location in whole or in part shall exceed fifteen (15) days during any billing period hereunder.

6. CONTRACTOR'S FACILITIES

(a) The Contractor, at his expense, except as otherwise provided for herein shall furnish, install, operate, and maintain all facilities required to furnish service hereunder to, and to measure the service at, the point of delivery specified in the Utility Service Specifications. Title to all of these facilities shall remain in the Contractor and he shall be responsible for all loss of or damage to those facilities except that arising out of the fault or negligence of the Government, its agents or its employees. All taxes and other charges in connection therewith, together will all liability arising out of the negligence of the Contractor in the construction, operation, or maintenance of these facilities, shall be assumed by the Contractor.

(b) The Government hereby grants to the Contractor, free of any rental or similar charge, but subject to the limitations specified in this contract, a revocable permit to enter the service location for any proper purpose under this contract, including use of the site or sites agreed upon by the parties hereto for the installation, operation, and maintenance of the facilities of the Contractor required to be located upon Government premises. Authorized representatives of the Contractor will be allowed access to the facilities of the Contractor at suitable times to perform the obligations of the Contractor with respect to these facilities. It is expressly understood that the Government may limit or restrict the right of access herein granted in any manner considered to be necessary for the national security.

TECHNICAL AND GENERAL PROVISIONS FOR UTILITY SERVICE (Cont'd)

(c) The facilities shall be removed and Government premises restored to their original condition, ordinary wear and tear excepted, by the Contractor at his expense within a reasonable time after the Government shall revoke the permit herein granted and in any event within a reasonable time after termination of the contract, provided, that in the event of termination due to fault of the Contractor these facilities may be retained in place at the option of the Government until service comparable to that provided for hereunder is obtained elsewhere.

7. CONFLICTS. To the extent of any inconsistency between the provisions of this contract, and the provisions of any schedule, rider, or exhibit incorporated in this contract by reference or otherwise, the provisions of the contract shall control.

8. OTHER STANDARD PROVISIONS

(a) The following clauses of the Armed Services Procurement Regulation are hereby incorporated by reference and made a part of this contract in accordance with Section VII, paragraph 7-001, of ASPR dated 31 March 1969, Rev. 1:

Clause Numer	Clause Title	Clause Date
7-103.1	DEFINITIONS	FEB 1962
7-103.8	ASSIGNMENT OF CLAIMS	FEB 1962
7-103.12(a)	DISPUTES	JAN 1958
7-103.19	OFFICIALS NOT TO BENEFIT	JUL 1949
7-103.20	COVENANT AGAINST CONTINGENT FEES	JAN 1958
7-104.15	EXAMINATION OF RECORDS	MAR 1971
7-104.16	GRATUITIES	MAR 1952
12-203	CONVICT LABOR	MAR 1949
12-303	CONTRACT WORK HOURS STANDARDS ACT	JUN 1964
12-804	EQUAL OPPORTUNITY	APR 1971

(b) Disputes (Amendment of Sep 1968). Add the following to Clause No. 7-103.12(a):

"(c) The provisions of (a) above shall not apply to disputes which are subject to the jurisdiction of a Federal, State, or other appropriate regulatory body. The provisions of (a) above shall also be subject to the requirements of the law with respect to the rendering of utility services and the collection of regulated rates. (1968 SEP)".

TECHNICAL AND GENERAL PROVISIONS FOR UTILITY SERVICE (Cont'd)

9. CONNECTION CHARGES

(a) Charges. In consideration of the furnishing and installation by Contractor at his expense of facilities to provide capacity in contractor's sewage collection, treatment and disposal system to collect, treat and dispose of Government's sewage in accordance with the Sewerage Specifications attached hereto, the Government shall pay the Contractor, as a connection charge, within thirty (30) days after commencement of service, the sum of $1,000,000.00. The Government shall also pay Contractor, as a service lateral charge, after receipt of satisfactory evidence of completion of facilities connecting Government's system to Contractor's system as shown on Exhibit "A" attached hereto and made a part hereof, the actual cost thereof, but not to exceed a sum of $22,000.00, provided that as a condition precedent to final payment, Contractor, if required by the Contracting Officer, shall execute a release in terms acceptable to the Contractor Officer of claims against the Government arising under or by virtue of the installation. The lateral service charge shall include the costs to Contractor for a lateral connection from the Government's service area boundary to Contractor's facilities, a metering device and costs for design, construction and inspection. Notwithstanding the payment by the Government of a connection charge, the facilities to be supplied by the Contractor under this contract shall remain the property of Contractor and, at all times during the life of this contract or any renewals thereof, shall be operated and maintained by Contractor at his expense.

(b) Termination Prior to Completion of Facilities. The Government reserves the right to terminate this contract at any time prior to completion of the facilities provided for herein with respect to which the Government is to pay a connection charge. In the event the Government exercises this right, the Contractor shall be paid fair compensation, exclusive of profit, with respect to those facilities.

10. SPECIAL FACILITIES CHARGE

Special facilities charge. The Government shall pay Contractor a monthly special facilities charge which represents one sixtieth of the sum of two hundred thousand dollars, ($200,000) plus associated costs of ownership and financing for facilities to be constructed by Contractor during a five (5) year period subsequent to the effective date of the contract. Such facilities charge represents the Government's pro-rata share of special facilities required to furnish sewage service by the Contractor.

7-5-72 592 3333

HM:kb

Attached to and made part of
Contract No. N62474-71-C-3711

TECHNICAL AND GENERAL PROVISIONS FOR UTILITY SERVICE (Cont'd)

The monthly charge shall be three thousand nine hundred and forty six dollars ($3,946). Such charges will terminate at the expiration of a sixty month period following the effective date of this contract. In the event the Government terminates this contract prior to the expiration of the five (5) year period, the unpaid balance of the special facilities charge shall become due and payable to the Contractor.

HM:kb

Attached to and made a part of
Contract No. N62474-71-C-3711

SEWERAGE SERVICE SPECIFICATIONS

1. PREMISES TO BE SERVED: Marine Corps Air Station, El Toro, Santa Ana, California

2. ESTIMATED SERVICE:
Estimated annual volume: 200,000,000 gallons
(Government is in no way obligated to deliver nor it is restricted to the above estimate.)

3. SERVICE TO BE RENDERED. The Contractor shall furnish a sanitary sewer connection and sanitary sewerage service as required by the Government and shall receive, carry, treat and dispose of all sanitary sewage originating at the project in such amounts as the Government desires to release into Contractor's sewer system and as governed by the Rate of Delivery specified hereinafter, and in a manner and by such means as will constitute no hazard to the public health. The Contractor shall operate his sewage facilities in conformity with applicable laws, rules, and regulations promulgated by Federal, state and local authorities.

4. POINT OF DELIVERY. The sewage shall be delivered to the Contractor by the Government at the boundary of the Government property as shown on Exhibit "A".

5. RATE OF DELIVERY. The amount of sewage delivered to the Contractor for treatment, reclamation or disposal shall not exceed an average daily flow of 1.5 million gallons per day determined on the basis of a 30 day period commencing on the first day of a calendar month. Such flow shall not exceed a rate of 4.5 cubic feet per second.

6. SEWAGE AND WASTE WATER REQUIREMENTS. The quality of sewage and waste water delivered by Government to Contractor shall comply with the quality criteria set forth in Exhibit "B" attached hereto and made a part hereof. Such quality criteria may be amended from time to time by Contractor, provided, that such modifications are applicable throughout the area within the boundaries of the Contractor.

7. QUALITY MONITORING PROGRAM. Government shall establish, at its cost, a facility for qualitatively monitoring the sewage and waste water delivered to the Contractor for treatment, reclamation or disposal. The program shall be as mutually agreed upon by the Government and the Contractor.

HM:kb

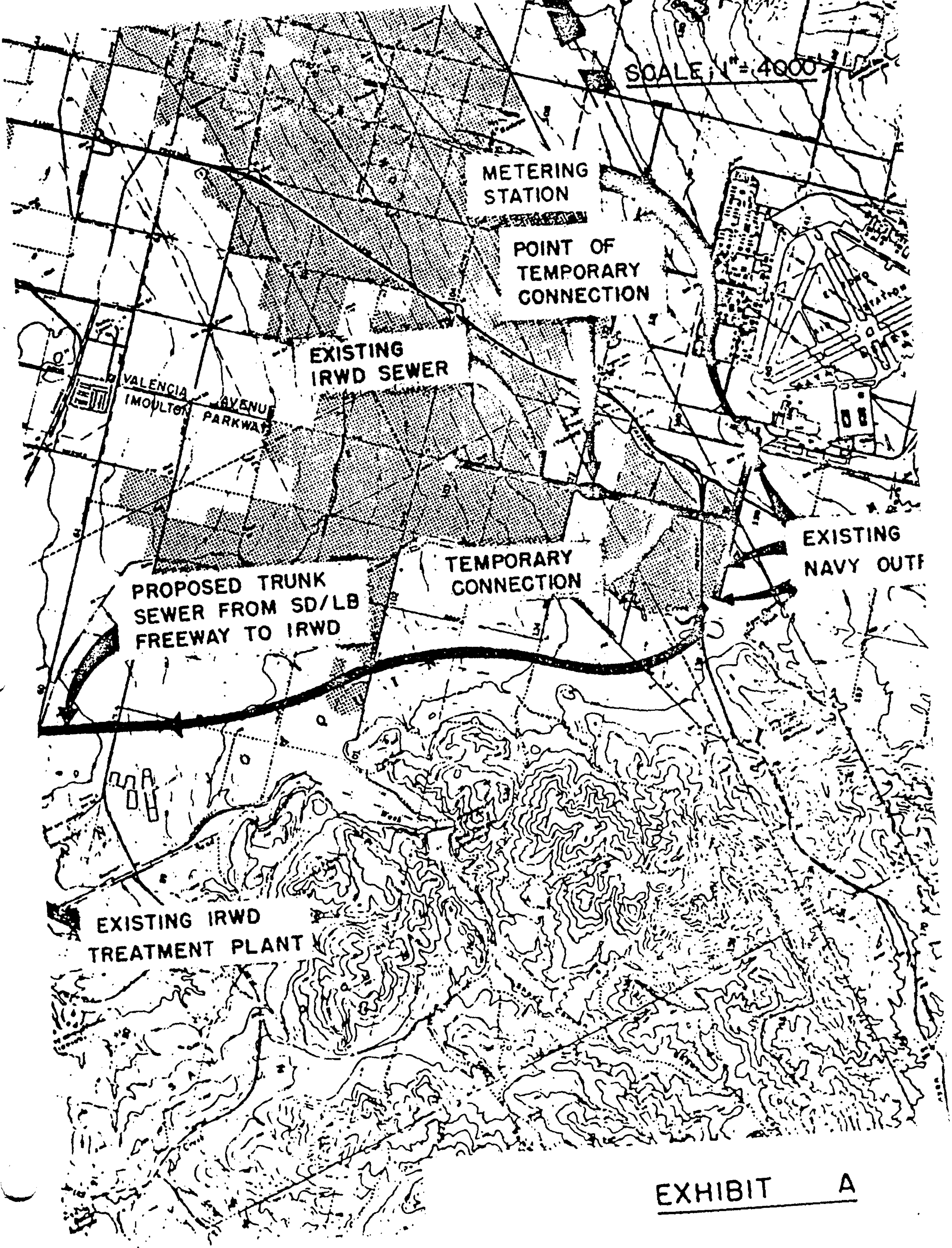
Attached to and made a part of
Contract No. N62474-71-C-3711

RATE SCHEDULE

1. Government shall pay to Contractor its cost for handling sewage received by Contractor from Government hereunder. The cost for treating and disposal of sewage of Government to the extent provided for herein shall include all maintenance, operation, repair, replacement and relocation costs of Contractor. The foregoing shall be computed by Contractor in accordance with generally accepted accounting practices and principles. Contractor's cost shall be determined by deducting from the aforementioned costs, all net revenues of Contractor derived from the sale of treated effluent and other by-products. The cost to be paid by Government to Contractor shall be determined by multiplying the number of units of ONE MILLION (1,000,000) gallons of sewage received by Contractor from Government hereunder, during a billing period, by the amount of Contractor's cost per unit of ONE MILLION (1,000,000) gallons of providing such service computed in the manner hereinabove provided for.

2. Rate per 1,000,000 gallons $ 225.00 . (in June 1972)

3. This charge shall be renegotiated annually based upon Contractor's actual costs for the preceeding twelve month period, commencing on the anniversary date of this contract.



SCALE 1" = 4000'
METERING STATION
POINT OF TEMPORARY CONNECTION
EXISTING IRWD SEWER
VALENCIA AVENUE
MOULTON PARKWAY
EXISTING NAVY OUTF
TEMPORARY CONNECTION
PROPOSED TRUNK SEWER FROM SD/LB FREEWAY TO IRWD
EXISTING IRWD TREATMENT PLANT

EXHIBIT A

EXHIBIT B

RULES AND REGULATIONS OF THE IRWD GOVERNING QUALITY OF SEWAGE AS OF APRIL 1971

Sec E 8 - Quality of Sewage

No person shall discharge or cause to be discharged any of the following described waters or wastes to any District sewer:

(a) Any gasoline, benzene, naptha, fuel oil, or other flamable or explosive liquid, solid or gas.

(b) Any ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, paunch manure, or any other solid or discuous substance capable of causing obstruction to the flow in sewers or other interference with the proper operation of the sewerage works.

(c) Any waters or wastes containing toxic or poisonous solids, liquids, or gases in sufficient quantity, either by singly or by interaction with other wastes, to injure or interfere with any sewage treatment process, constitute a hazard to humans or animals, create a public nuisance, or create any hazard in the receiving waters of the sewerage treatment plant.

(d) Any noxious or malodorous gas or substance capable of creating a public nuisance.

(e) Having a temperature higher than 85° F.

(f) Containing more than 0.5 parts per million of dissolved sulphides.

(g) Having a pH lower than 6.5 or higher than 9.0, or having any other corrosive property capable of causing damage or hazard to structures, equipment, and personnel of the District.

(h) Containing more than 200 parts per million, by weight, of fat, oil or grease.

(i) Any garbage which is not shredded so that all particles are less than one-half inch in any dimension.

(j) Any suspended solids of such character and quantity that unusual attention or expense is required to handle such materials in trunk sewers or at the sewage treatment plant.

(k) Any brine waste from a home regenerated water softener unit. Installation of such home regenerated water softener units in the District will not be allowed unless the applicant demonstrates brine discharge facilities other than District sewers.

APPENDIX U

INDUSTRIAL WASTEWATER CLASS I PERMIT
ORANGE COUNTY WATER DISTRICT

INDUSTRIAL WASTEWATER
CLASS I PERMIT

Permit No: 14-1-135

FOR DISCHARGE OF WASTEWATER ISSUED BY
COUNTY SANITATION DISTRICT No. 14 OF ORANGE COUNTY

In accordance with the provisions of the Wastewater Discharge Regulations of County Sanitation District 14 of Orange County, herein referred to as "District",

MARINE CORPS AIR STATION
FACILITIES MANAGEMENT DEP
SANTA ANA, CA 92709

hereinafter referred to as "Permittee", is hereby authorized to discharge industrial wastewater from the above identified facility into the District's sewerage system in accordance with the conditions set forth in this permit. Such conditions are as specified in the following parts of this permit:

Part 1 - Effluent Limits and Flow Basis
Part 2 - Monitoring, Notification, and Reporting Requirements
Part 3 - Standard Conditions
Part 4 - Special Conditions

Compliance with this permit does not relieve the Permittee of its obligation to comply with the District's Wastewater Discharge Regulations, any applicable pretreatment regulations, standards or requirements under local, State, and Federal laws, including any such regulations, standards, requirements or laws that may become effective during the term of this permit. Non-compliance with any term or condition of this permit constitutes a violation of the District's Wastewater Discharge Regulations.

This permit shall become effective on 1/01/1992 and shall expire on 4/30/1993.

By:

Margaret H. Nellor
Source Control Manager

Issued on November 15, 1991.

COUNTY SANITATION DISTRICTS OF ORANGE COUNTY, CALIFORNIA
10844 Ellis Avenue P.O. Box 8127
Fountain Valley, CA 92728-8127
(714) 962-2411

PART 1 - EFFLUENT LIMITS AND FLOW BASIS

During the period from January 1, 1992 to the expiration date of the permit, Permittee is authorized to discharge industrial wastewater into the sewerage system tributary to the District's sewerage facilities. The effluent discharge shall not exceed either the following concentration limits in mg/L or the mass emission rate limits in Lbs/day, based on 1100000 gallons per day (gpd) of wastewater flow at the sampling point.

Company Name	MARINE CORPS AIR STATION	Permit No. 14-1-135	Effective Date: 1/01/92
Sewer Address	FAC. MANAG.DEPT,CODE IJG SANTA ANA, CA 92709	Flow Base: 1100000 gpd	Expiration Date: 4/30/1993
		Category: CSOOC 400CSD	Orig. Issue Date: 5/01/1991

DISCHARGE LIMITS

CONSTITUENT	Instantaneous Limit, mg/L	Daily Max mg/L	4-Day Avg mg/L	Monthly Avg mg/L	Daily Max Lbs/day	Monthly Avg Lbs/day
Arsenic (As)	2.00	2.00	■	■	■	■
Cadmium (Cd)	1.00	1.00	■	■	■	■
Chromium Total (Cr)	2.00	2.00	■	■	■	■
Copper (Cu)	3.00	3.00	■	■	■	■
Lead (Pb)	2.00	2.00	■	■	■	■
Mercury (Hg)	0.03	0.03	■	■	■	■
Nickel (Ni)	10.00	10.00	■	■	■	■
Silver (Ag)	5.00	5.00	■	■	■	■
Zinc (Zn)	10.00	10.00	■	■	■	■
Combined Metals (Platinum, Palladium, Gold)	■	■	■	■	■	■
Total Metals (Cr, Cu, Ni, Zn)	■	■	■	■	■	■
Cyanide (Total)†	5.00	5.00	■	■	■	■
Cyanide (Amenable)†	1.00	1.00	■	■	■	■
Polychlorinated Biphenyls	0.01	0.01	■	■	■	■
Pesticides	0.01	0.01	■	■	■	■
Total Toxic Organics	0.58	0.58	■	■	■	■
Total Phenols	■	■	■	■	■	■
Sulfide (Total)	5.00	5.00	■	■	■	■
Sulfide (Dissolved)	0.50	0.50	■	■	■	■
Oil & Grease (Mineral or Petroleum)	100.0	100.0	■	■	■	■
Ammonia (as N)	■	■	■	■	■	■
Biological Oxygen Demand (BOD)	■	■	■	■	15000	10000
Chemical Oxygen Demand (COD)	■	■	■	■	■	■
Total Suspended Solids (TSS)	■	■	■	■	■	■
pH	6 - 12	6 - 12	■	■	■	■

SAMPLING POINT LOCATION: The above effluent limits apply at the sampling point located on the east side of the base, off of Perimeter Road. The sample point is the discharge manhole and represents all industrial wastewater discharge from the facility.

* Production-based limits

† Cyanide limits apply at the sampling point after cyanide treatment, but prior to dilution with other streams. If there is no cyanide treatment, the sample must be taken at the end of the cyanide process before dilution with other process streams. In the absence of cyanide process, the limits apply at the sampling point location described above (end of pipe).

PART 2 - SELF-MONITORING, NOTIFICATION AND REPORTING REQUIREMENTS

I. SELF-MONITORING REQUIREMENTS

Permittee shall conduct monitoring of its own wastewater effluent for the purpose of determining the status of compliance/non-compliance and user charges. Based on the results, Permittee shall make the necessary adjustments/corrections to bring the wastewater discharge into immediate compliance with its permitted limits. The specific requirements are as follows:

A. Monitoring Requirements

From the effective date of the permit and until the permit is terminated or revised, Permittee shall monitor its wastewater discharge for the following parameters at the indicated frequency:

Parameters	Measurement Frequency	Sample Type[1]
Heavy Metals:		
Silver	quarterly	composite
Cadmium	quarterly	composite
Chromium	quarterly	composite
Copper	quarterly	composite
Nickel	quarterly	composite
Lead	quarterly	composite
Zinc	quarterly	composite
Cyanides:		
None		
Total Toxic Organics:		
601/602	semi-annual	grab
Others:		
BOD	quarterly	composite
TSS	quarterly	composite
Oil/Grease	None	
Flow (gal/day)[2]		
pH[2]		

1 Sample type is either composite or grab as defined in the District's Wastewater Regulations (Ordinance) under Section 102.
2 Flow and pH should be measured concurrently with composite sampling for heavy metals.

B. Representative Sampling and Laboratory Analyses

Samples and measurements taken as required herein shall be representative of the volume and nature of the regulated industrial discharge during hours of production. All samples shall be taken at the sampling point location. All equipment used for sampling and analysis must be routinely calibrated, inspected, and maintained to ensure its accuracy. All sampling and laboratory analyses shall be conducted in accordance with Attachment A.

C. **Frequency, Sampling Schedule and Due Dates for Submission of Reports**

Sampling of wastewater effluent and reporting of results shall be done in accordance with the schedule shown below. Sampling may be performed any day within the specified date range. If sampling cannot be conducted within the specified date for any valid reason, the District must be notified in advance and in writing, of the reason(s) for the inability to sample and the new proposed sampling date.

HEAVY METALS		Sampling Date	Report Submission Due Date
Third Quarter	(Jan 1992 - Mar 1992)	February 10 - February 21	March 18, 1992
Fourth Quarter	(Apr 1992 - Jun 1992)	June 8 - June 19	July 9, 1992
First Quarter	(Jul 1992 - Sep 1992)	August 24 - September 4	September 24, 1992
Second Quarter	(Oct 1992 - Dec 1992)	October 19 - October 30	November 19, 1992
Third Quarter	(Jan 1993 - Mar 1993)	February 15 - February 26	March 18, 1993
Fourth Quarter	(Apr 1993 - Jun 1993)	June 14 - June 25	July 15, 1993
CYANIDES		Sampling Date	Report Submission Due Date
Second half	(Jan 1992 - Jun 1992)		
First half	(Jul 1992 - Dec 1992)		
Second half	(Jan 1993 - Jun 1993)		
TOTAL TOXIC ORGANICS (TTO)		Sampling Date	Report Submission Due Date
Second half	(Jan 1992 - Jun 1992)	February 10 - February 21	March 18, 1992
First half	(Jul 1992 - Dec 1992)	August 24 - September 4	September 24, 1992
Second half	(Jan 1993 - Jun 1993)	February 15 - February 26	March 18, 1993
BOD and TSS		Sampling Date	Report Submission Due Date
Third Quarter	(Jan 1992 - Mar 1992)	February 10 - February 21	March 18, 1992
Fourth Quarter	(Apr 1992 - Jun 1992)	June 8 - June 19	July 9, 1992
First Quarter	(Jul 1992 - Sep 1992)	August 24 - September 4	September 24, 1992
Second Quarter	(Oct 1992 - Dec 1992)	October 19 - October 30	November 19, 1992
Third Quarter	(Jan 1993 - Mar 1993)	February 15 - February 26	March 18, 1993
Fourth Quarter	(Apr 1993 - Jun 1993)	June 14 - June 25	July 15, 1993
OIL AND GREASE		Sampling Date	Report Submission Due Date
Third Quarter	(Jan 1992 - Mar 1992)		
Fourth Quarter	(Apr 1992 - Jun 1992)		
First Quarter	(Jul 1992 - Sep 1992)		
Second Quarter	(Oct 1992 - Dec 1992)		
Third Quarter	(Jan 1993 - Mar 1993)		
Fourth Quarter	(Apr 1993 - Jun 1993)		

D. **Requirements for Reporting Results**

1. **Self-Monitoring Reports**

Permittee shall submit a Self-Monitoring Report (SMR) on the date(s) specified above. Monitoring results shall be summarized and reported on an SMR form as shown in Attachment A. The report shall indicate the concentration of all pollutants in the effluent for which sampling and analyses were performed, including water meter readings required for flow measurement. The District will not accept formats other than what is shown in the SMR form; therefore, forms provided by the District or replicates must be used for reporting of results. The SMR form shall be completely filled-out, with copies of all laboratory results attached.

2. **Signatory Requirements**

Prior to submittal of the SMR to the District, the results shall be verified and signed under penalty of perjury, by an authorized company official as defined in 40 CFR 403.

E. **Additional Monitoring Requirements in Response to Non-compliance**

1. **Resampling**

Upon submission of the SMR to the District by the required due date, the District will process the results for mass emission rate calculations, review the concentration results, and notify Permittee of the results. If the results indicate that a violation of the applicable concentration and/or mass discharge limits has occurred, a Notice of Violation will be issued and Permittee must repeat the sampling and pollutant analyses of the required parameters, as specified by the District, within 30 days of issuance of the Notice of Violation.

2. **Reporting**

a. The monitoring results shall be submitted within 20 days of completion of the resampling specified in E.1.

b. The requirements for reporting results, as described in D.1 and D.2, shall be followed for the additional monitoring requirements in response to non-compliance.

II. **NOTIFICATION REQUIREMENTS**

A. **Permittee shall comply with the notification requirements set forth in Section 501 of the District's Ordinance:**

1. Notification of Spill and Slug Loading

2. Notification of Bypass

B. **Notification regarding Planned Changes**

Permittee shall notify the District 90 days in advance prior to any facility expansion, production increase, or process modifications which may result in new or substantially increased discharges or a change in the nature of the discharge. Permittee shall notify the District in writing of the proposed expansion and shall submit any information requested by the District for evaluation of the affect of such expansion on the Permittee's discharge to the sewerage system.

III. OTHER REPORTING REQUIREMENTS

A. Slug Discharge Control Plan

Upon request by the District, Permittee is required to submit a Slug Discharge Control Plan on a biannual basis, that will address how the Permittee will respond to spills, bypass, and any accidental discharges, that may result in a violation of any permit limits or conditions, or may significantly exceed the normal flow, or pollutant loading. The plan shall contain detailed procedures to be followed by the permittee in responding to a slug discharge at the Permittee's facility. The procedures established shall include provisions to eliminate endangerment of human health by facilitating containment and clean-up of the slug discharge.

The Slug Discharge Control Plan, at a minimum, must contain the following:

1. Description of the permittee's sewer discharge practices including non-routine batch discharges.
2. Description of stored chemicals including type and characteristic, volume, and chemical hazard classification.
3. Procedures to prevent slug discharges to the sewer system.
4. Description of equipment for responding to slug discharges.
5. Procedures for inspection and maintenance of the chemical storage areas to assure proper daily handling.
6. A copy of an operation log sheet recording the maintenance performed, volume of spill, and corrective measures taken.
7. Procedures for proper training of key personnel for handling slug discharges.
8. Emergency telephone numbers for promptly reporting slug discharges to the appropriate governmental agencies.

B. Waste Minimization Requirements

Upon request by the District, Permittee shall provide waste minimization plans to conserve water, investigate product substitution, provide inventory control, implement employee education, and other steps as necessary to minimize waste produced.

C. Water and Tax Bill Submittal

Permittee shall submit to the District, copies of Water and Tax Bills within 30 days of receipt.

D. Changes in Company Information

Permittee shall immediately inform the District of any changes or inaccuracies in the following company information which is currently on file:

COMPANY NAME MARINE CORPS AIR STATION	PHONE 726-2821 FAX 726-2639	LOCAL SEWERING AGENCY IRWD
MAILING ADDRESS FACILITIES MANAGEMENT DEP SANTA ANA, CA 92709	CHIEF OPERATING OFFICER ENSIGN JOHN KLIEN DEPUTY ENV.DIR.	NO. OF EMPLOYEES WORK DAYS/YEAR 365
SERVICE ADDRESS FAC. MANAG.DEPT,CODE IJG SANTA ANA, CA 92709	CONTACT	S.I.C. NUMBER 9711

E. Falsifying Information

Knowingly making any false statement on any report or other document required by this permit or knowingly rendering any monitoring device or method inaccurate, is a crime and may result in the imposition of criminal sanctions and/or civil penalties.

PART 3 - STANDARD CONDITIONS

I. GENERAL PROHIBITIONS

Permittee is required to comply with the general prohibitions and limits on discharges set forth in Article 2 of the District's Ordinance:

A. Prohibited Discharges
B. Prohibition on Dilution
C. Prohibition on Surface Runoff and Groundwater
D. Prohibition on Unpolluted Water
E. Prohibition on Radioactive Wastes
F. Prohibition on the Use of Grinders
G. Prohibition on Point of Discharge
H. Limits on Wastewater Strength and Characteristics
I. Prohibition on Medical Waste
J. Prohibition on Disposal of Spent Solutions and Sludges

II. CIVIL PENALTIES

Any person who violates any provision of the District's Ordinance; or any permit condition, prohibition or effluent limitation; or any suspension or revocation order shall be liable civilly for a penalty pursuant to Article 6 of the District's Ordinance, for each day in which such violation occurs.

III. CRIMINAL PENALTIES

Any person who violates any provision of the District's Ordinance or any permit condition, prohibition or effluent limit, is guilty of a misdemeanor, which upon conviction is punishable by a fine not to exceed one thousand dollars ($1,000), or imprisonment for not more than six (6) months in the County Jail, or both. Each day in violation constitutes a new and separate violation and shall be subject to the penalties contained herein.

IV. SEVERABILITY

The provisions of this permit are severable. If any provision of those permit limits and/or requirements, or the application thereof, to the Permittee is held invalid, the remainder of the permit limits and/or requirements shall remain in full force and effect.

V. OTHER CONDITIONS

A. Permittee is required to comply with all regulations and discharge limits in the District's Ordinance and any attachments to this permit.

B. Except as expressly authorized by the District, upon the sale or transfer of ownership of the business for which this permit is issued, this permit shall be void. The permittee shall notify the District in writing prior to the transfer of ownership and shall give a copy of the existing permit to the new owner or operator.

C. Permits issued under the District's Ordinance are for a specific user, for a specific operation at a specific location, and create no vested rights. Discharge permits, their concentration limits or their mass emission rates shall not be transferred for an operation at a different location.

D. Permittee shall maintain plant records relating to wastewater discharge and waste manifests for a minimum of three years.

PART 4 - SPECIAL CONDITIONS FOR PERMIT NO. 14-1-135

- Permittee shall comply with the conditions specified in **Attachment B**

ATTACHMENTS TO

PERMIT NO. 14-1-135

MARINE CORPS AIR STATION

ATTACHMENT A
PERMIT NO. 14-1-135
MARINE CORPS AIR STATION

SELF-MONITORING REQUIREMENTS

1. **Sampling and Analysis of Heavy Metals**

a. **Composite Sampling.** Permittee shall collect and analyze a 24-hour composite sample of the wastewater effluent for heavy metals at a frequency specified in **Part 2** of the permit. All effluent sampling must be conducted using an automatic sampling device which is capable of collecting samples at 15-minute intervals during all hours of discharge in a 24-hour day. Flow-proportional samples are acceptable with a minimum of 96 samples collected per 24 hours of discharge. For batch dischargers, a grab sample is acceptable for a well-mixed batch, otherwise a composite sample during the period of discharge must be obtained.

b. **Discharge Flow.** Water meter readings shall be obtained during the start and end of composite sampling to determine the volume of water discharged during the 24-hr sampling period. Meter readings are necessary to determine the total flow needed for calculation of daily mass emission rate for the actual wastewater discharged. Additionally, the start and stop times must be recorded. The units in which the water meter readings are expressed must be properly ascertained.

Permittee shall measure and record daily total flow using flow measurement devices and methods that ensure an accurate measurement of the volume of monitored discharge. The use of effluent meters provides an accurate measurement of the volume discharged; however, in the absence of effluent meters, the Districts accept the use of incoming water meters or process meter totalizers with appropriate standard deductions such as domestic, process, and landscape losses. These deductions will be applied by the Districts, upon processing of the Self-Monitoring report, to determine the volume of wastewater discharged to the sewer system. The devices shall be installed, calibrated, and maintained to ensure that the accuracy of the measurements are consistent with the accepted capability of that device.

c. **Laboratory Analyses.** All wastewater samples shall be analyzed in accordance with the appropriate procedures contained in 40 CFR 136. Where 40 CFR 136 does not include sampling or analytical techniques for the pollutants in question, analyses shall be performed using the most current edition of "Standard Methods for the Examination of Water and Wastewater". Wastewater analysis shall be performed by a laboratory utilizing the approved method for performing the analyses on the required constituents. Upon the Districts' request, Permittee shall obtain from their laboratory and furnish to the Districts, information regarding test methods and equipment used, including quality assurance/quality control (QA/QC) information. Other information deemed necessary by the Districts to determine the adequacy, accuracy, and precision of the results may also be required.

2. **Sampling and Analysis for Cyanides**

a. **Sampling.** Permittee shall collect and analyze a sample of its wastewater effluent for cyanides at a frequency specified in **Part 2** of the Permit. All sampling for cyanide must be conducted by taking a grab sample of the wastewater after cyanide treatment, but prior to dilution with other streams. If there is no cyanide treatment, the sample must be taken at the end of the cyanide process before dilution with other process streams. Proper sampling and preservation techniques must be used to ensure representative sample results.

b. **Laboratory Analyses.** All wastewater samples shall be analyzed for cyanides in accordance with the appropriate procedures contained in 40 CFR 136 using EPA Methods. Wastewater analysis shall be performed by a laboratory utilizing the approved method for performing the analyses on the required constituents. Upon the Districts' request, Permittee shall obtain from their laboratory and furnish to the Districts, information regarding test methods and equipment used, including QA/QC information. Other information deemed necessary by the Districts to determine the adequacy, accuracy, and precision of the results may also be required.

3. **Sampling and Analysis for Total Toxic Organics (TTO)**

a. **Sampling.** Permittee shall collect and analyze samples of the wastewater effluent for TTO at a frequency specified in **Part 2** of the permit. All effluent sampling for volatile organic compounds must be conducted by taking grab samples of the wastewater effluent. A minimum of four grab samples shall be taken independently during hours of operation within a 24-hr period. Each sample shall be analyzed independently for toxic organic constituents present in the facility. The average concentration from the four grab sample results with concentrations greater than 10 μg/L shall be used to determine compliance with TTO mass emission and/or concentration limits.

b. **Laboratory Analyses.** All wastewater samples shall be analyzed in accordance with the appropriate procedures contained in 40 CFR 136 using EPA Methods (i.e., for Purgeable Halocarbons and Aromatics, use Methods 601 and 602, or 624). Wastewater analysis shall be performed by a laboratory utilizing the approved method for performing the analyses on the required constituents. Upon the Districts' request, Permittee shall obtain from their laboratory and furnish to the Districts, information regarding test methods and equipment used, including QA/QC information. Other information deemed necessary by the Districts to determine the adequacy, accuracy, and precision of the results may also be required.

4. **Sampling and Analysis of BOD and TSS**

a. **Composite Sampling.** Permittee shall collect and analyze a 24-hour composite sample of the wastewater effluent for BOD and TSS at a frequency specified in **Part 2** of the permit. All effluent sampling must be conducted using an automatic sampling device which is capable of collecting samples at 15-minute intervals during all hours of discharge in a 24-hour day. Flow-proportional samples are acceptable with a minimum of 96 samples collected per 24 hours of discharge. For batch dischargers, a grab sample is acceptable for a well-mixed batch, otherwise a composite sample during the period of discharge must be obtained.

b. **Discharge Flow.** Water meter readings shall be obtained during the start and end of composite sampling to determine the volume of water discharged during the 24-hr sampling period. Meter readings are necessary to determine the total flow needed for calculation of daily mass emission rate for the actual wastewater discharged. Additionally, the start and stop times must be recorded. The units in which the water meter readings are expressed must be properly ascertained.

Permittee shall measure and record daily total flow using flow measurement devices and methods that ensure an accurate measurement of the volume of monitored discharge. The use of effluent meters provides an accurate measurement of the volume discharged; however, in the absence of effluent meters, the Districts accept the use of incoming water meters or process meter totalizers with appropriate standard deductions such as domestic, process, and landscape losses. These deductions will be applied by the Districts, upon processing of the Self-Monitoring report, to determine the volume of wastewater discharged to the sewer system. The devices shall be installed, calibrated, and maintained to ensure that the accuracy of the measurements are consistent with the accepted capability of that device.

c. **Laboratory Analyses.** All wastewater samples shall be analyzed in accordance with the appropriate procedures contained in 40 CFR 136 using EPA Method. Wastewater analysis shall be performed by a laboratory utilizing the approved method for performing the analyses on the required constituents. Upon the Districts' request, Permittee shall obtain from their laboratory and furnish to the Districts, information regarding test methods and equipment used, including QA/QC information. Other information deemed necessary by the Districts to determine the adequacy, accuracy, and precision of the results may also be required.

5. **Sampling and Analysis for Oil and Grease (O&G)**

a. **Sampling.** Permittee shall collect and analyze samples of the wastewater effluent for O&G at a frequency specified in **Part 2** of the permit. All effluent sampling for O&G must be conducted by taking a grab sample of the wastewater effluent at the sample point location.

b. **Laboratory Analyses.** All wastewater samples shall be analyzed in accordance with the appropriate procedures contained in 40 CFR 136 using EPA Method. Wastewater analysis shall be performed by a laboratory utilizing the approved method for performing the analyses on the required constituents. Upon the Districts' request, Permittee shall obtain from their laboratory and furnish to the Districts, information regarding test methods and equipment used, including QA/QC information. Other information deemed necessary by the Districts to determine the adequacy, accuracy, and precision of the results may also be required.

SMR No.

SELF-MONITORING REPORT FORM: HEAVY METALS, TSS, AND BOD

REQUIRED PARAMETERS	Sampling Dates	Submission Dates

COMPANY: **Permit No.**

CONTACT: ____________________ SAMPLE DATE: ____________________

SAMPLING START TIME: ____________________ WATER METER LOCATION: ____________________

SAMPLING STOP TIME: ____________________ SAMPLE POINT LOCATION: ____________________

OF COMPOSITE HOURS: ____________________ # OF DISCHARGE/OPERATING HOURS: ____________________

WATER METER READINGS				Districts' use only
	Stop	Start	Units	
1			☐ gal ☐ cu.ft. ☐ Other________	
2			☐ gal ☐ cu.ft. ☐ Other________	
3			☐ gal ☐ cu.ft. ☐ Other________	
Composite pH:	☐ Incoming water meter ☐ Process (shop) meter ☐ Effluent Meter			

SAMPLING RESULTS

HEAVY METALS								TSS	BOD
mg/L									
EPA Method									

COMMENTS:

EXAMPLE ONLY

Forms will be sent to you under a separate cover

Please check:
Laboratory Analysis Reports attached: ( ) Yes ( ) No
Composite samples obtained using automatic hourly sampling device: ( ) Yes ( ) No

I have personally examined and am familiar with the information submitted in this document. Based upon my inquiry of those individuals immediately responsible for obtaining the information reported herein, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Signature ____________________ Title ____________________

SMR No.

SELF-MONITORING REPORT FORM: TOTAL TOXIC ORGANICS, CYANIDE, AND OIL & GREASE

REQUIRED PARAMETERS	Sampling Date	Submission Due Date

COMPANY:

Permit No.

CONTACT: ____________________

SAMPLE DATE: ____________________

SAMPLING TIME: ____________________

SAMPLE POINT LOCATION: ____________________

SAMPLING RESULTS

Constituent	CYANIDE mg/L		OIL & GREASE mg/L	TOTAL TOXIC ORGANICS (μg/L)				DISTRICTS' USE ONLY
	CN(T)	CN(A)						
EPA Method				601/602	604	624	625	
1								
2	■	■	■					
3	■	■	■					
4	■	■	■					
Ave.	■	■	■					

COMMENTS: ____________________

EXAMPLE ONLY

Forms will be sent to you under a separate cover

I have personally examined and am familiar with the information submitted in this document. Based upon my inquiry of those individuals immediately responsible for obtaining the information reported herein, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Signature ____________________ Title ____________________

ATTACHMENT B
PERMIT NO. 14-1-135
MARINE CORPS AIR STATION

1. MCAS, El Toro is required to continuously monitor and record at the wastewater monitoring station located east of Bee Canyon Wash for flow, pH, and electrical conductivity.

2. MCAS, El Toro is required to install water meters where needed to measure non-domestic flows. Water meters shall be read monthly.

3. The flow, pH, and electrical conductivity meters are to be serviced weekly and calibrated semi-annually, or as needed to maintain accuracy. Service and calibration records shall be made available upon request.

4. The maximum permitted flow from MCAS, El Toro shall be 1.5 MGD as stipulated in the service agreement between MCAS, El Toro and IRWD.

5. Monthly, a flow weighted 24-hour composite sample shall be taken at the industrial waste monitoring station and analyzed for BOD, suspended solids, pH, and electrical conductivity. A sample shall be taken every 15 minutes and 4 samples shall be composited into a single bottle, for a total of 96 samples in 24 bottles. Electrical conductivity and pH shall be measured for each bottle. Suspended solids and BOD analyses shall be performed on the flow weighted composite sample.

6. Monthly, a grab sample shall be taken at the wastewater monitoring station and analyzed for oil and grease.

7. Semi-annually, the sewage flowing through the wastewater monitoring station shall be sampled for Total Toxic Organics (TTO) according to EPA method 624/625. The list of TTO and their method of analysis is shown in Attachment C.

8. Semi-annually, the industrial wastewaters pumped from the Bee Canyon Wash and Agua Chinon Wash pretreatment stations shall be sampled for TTO according to EPA method 624/625. The list of TTO and their method of analysis is shown in Attachment C.

9. The TTO samples will be collected and analyzed according to the CSDOC Standard TTO monitoring program.

10. No limit shall be set on the electrical conductivity. This constituent will be used by IRWD as a guideline to determine the total dissolved solids discharged by MCAS, El Toro.

11. No limit shall be set on the BOD and suspended solids. If the measurements exceed 300 mg/l BOD or 375 mg/l suspended solids, the treatment cost of the excess mass of these constituents will be charged to MCAS, El Toro in accordance with the IRWD Rules and Regulations.

12. Monthly, a grab sample shall be collected at both the Bee Canyon Wash and Agua Chinon Wash pretreatment stations from the pump going directly to the sewer and analyzed for oil and grease.

13. Monthly, flows from both the Bee Canyon Wash and Agua Chinon Wash pretreatment stations shall be estimated based on the pump output and the elapsed running time of the pumps. The maximum permitted flow shall be 72,000 gallons per day which equates to both pumps running continuously.

14. The following table summarizes the above information. The MCAS, El Toro shall observe the following discharge limitations:

Constituent	Maximum Limitation mg/L	MGD
Flow[1]	-	1.5
pH[2]	-	-
Electrical Conductivity	-	-
BOD[3]	300	-
Suspended Solids[3]	375	-
Oil and Grease	100	-
Sum of EPA 624 & 625	0.58	-

[1]See point 4 of Attachment B
[2]See the first page of the permit
[3]See point #11 of Attachment B

15. The following table summarizes sampling parameters:

A) Monitoring Station Effluent Monitoring

Constituent	Units	Type of Sample		Analyze Bottle	Analyze Comp.	Minimum Frequency Analysis
Flow	MGD	-	-	-		Continuous
pH	-	-	-	-		Continuous
Electrical Conductivity	µmho/cm	-	-	-		Continuous
BOD	mg/L	24-hr composite		No	Yes	Monthly
Suspended Solids	mg/L	24-hr composite		No	Yes	Monthly
pH	mg/L	24-hr composite		Yes	Yes	Monthly
Electrical Conductivity	µmho/cm	24-hr composite		Yes	Yes	Monthly
Oil and Grease	mg/L	Grab	-	-		Monthly
EPA 624	mg/L	Grab (4-a day)[2]		-	-	Semi-annual
EPA 625	mg/L	24-hr composite		-	Yes	Semi-annual

B) Bee Canyon Wash and Agua Chinon Wash Effluents Monitoring

Constituent	Units	Type of Sample	Analyze Bottle	Analyze Comp.	Minimum Frequency Analysis
Flow	gpd	-	-	-	Monthly
Oil and Grease	mg/L	Grab -	-		Monthly
EPA 624	mg/L	Grab (4-a day)[2]	-	-	Semi-annual
EPA 625	mg/L	24-hr composite	-	Yes	Semi-annual

C) Non-Domestic Flows

Constituent	Units	Type of Sample	Analyze Bottle	Analyze Comp.	Minimum Frequency Analysis
Flow	Gal or cu. ft.	-	-	-	Monthly

[2]Four grab samples will be collected within a 24 hour period and will be composited by the laboratory at the time of analysis.

16. A monthly report containing this information is to be mailed to both CSDOC and IRWD and is due the first day of the second month following the month in which the samples were collected. (For example, the July sample results are due on September 1, 1989).

17. MCAS, El Toro agrees that it is bound by and is subject to all the provisions of the District's Ordinance as presently in effect or as may be amended from time to time hereafter during the term of this permit. The provisions of the ordinance shall be governing.

18. Nothing in this Attachment "B" shall prevent the District from enforcing the conditions, limitations, and requirements set forth in its Ordinance, or pursuing any of the enforcement actions authorized thereunder.

ATTACHMENT C
PERMIT NO. 14-1-135
MARINE CORP AIR STATION, EL TORO

Pesticides (625)

Aldrin
Chlordane
Dieldrin
4,4' - DDT
4,4' - DDE
4,4' - DDD
Alpha Endosulfan
Beta Endosulfan
Endosulfan Sulfate
Endrin
Endrin Aldehyde
Heptachlor
Heptachlor Epoxide
Alpha BHC
Beta BHC
Gamma BHC
Delta BHC
Toxaphene
PCB 1016
PCB 1221
PCB 1232
PCB 1242
PCB 1248
PCB 1254
PCB 1260

Base/Neutral Extractibles (625)

Acenaphthene
Benzidine
1,2,4, - Trichlorobenzene
Hexachlorbenzene
Hexachloroethane
Bis (2-Chloroethyl) Ether
2 - Chloronaphthalene
1,2 - Dichlorobenzene
1,3 - Dichlorobenzene
1,4 - Dichlorobenzene
3,3'- Dichlorobenzidine
2,4 - Dinitrotoluene
2,6 - Dinitrotoluene
1,2 - Diphenylydrazine
Fluoranthene
4 - Chlorophenyl Phenyl Ether
4 - Bromophenyl Phenyl Ether
Bis (2 - Chloroisopropyl) Ether
Bis (2 - Chloroethoxy) Methane
Hexachlorobutadiene
Hexachlorocyclopentadiene
Isophorone
Naphthalene
Nitrobenzene
N - Nitrosodimethylamine
N - Nitrosodi - N -Propylamine
N - Nitrosodiphenylamine
Bis (2 - Ethylhexyl) Phthalate
Butyl Benzyl Phthalate
Di - N - Butyl Phthalate
Di - N - Octyl Phthalate
Diethyl Phthalate
Dimethyl Phthalate
Benzo (A) Anthracene
Benzo (A) Pyrene
Benzo (B) Floranthene
Benzo (K) Floranthene
Chrysene
Acenaphthylene
Anthracene
1,12 - Benzoperylene
Fluorene
Phenanthrene
1,2,5,6 - Dibenzanthracene
Indeno (1,2,3, - CD) Pyrene
Pyrene
TCDD

Acid Extractibles (625)

2,4,6 - Trichlorophenol
P - Chloro - M - Cresol
2 - Chlorophenol
2,4 - Dichlorophenol
2,4 - Dimethylphenol
2 - Nitrophenol
4 - Nitrophenol
2,4 - Dinitrophenol
4,6 - Dinitro -O-Cresol
Pentachlorophenol
Phenol

Volatile Organics (624)

Acrolein
Acrylonitrile
Benzene
Carbon Tetrachloride
Chlorobenzene
1,2 - Dichloroethane
1,1,1 - Trichloroethane
1,1 - Dichloroethane
1,1,2 - Trichloroethane
1,1,2,2 - Tetrachloroethane
Chloroethane
Chloroform
1,1 - Dichloroethylene
1,2 - Trans Dichloroethylene
1,2 - Dichloropropane
1,2 - Dichloropropylene
Ethylbenzene
Methylene Chloride
Methyl Chloride
Methyl Bromide
Bromoform
Bromodichloromethane
Trichlorofluoromethane
Dichlorodifluoromethane
Dibromochloromethane
Tetrachloroethylene
Toluene
Trichloroethylene
Vinyl Chloride
Bis (chloromethyl) Ether
2 - Chloroethyl Vinyl Ether

COUNTY SANITATION DISTR
of ORANGE COUNTY, CALIFORN
10844 ELLIS AVENUE
P O BOX 8127
FOUNTAIN VALLEY, CALIFORNIA 92728
(714) 962-2411

COUNTY SANITATION DISTRICTS OF ORANGE COUNTY
SOURCE CONTROL DIVISION
ATTACHMENT "A" TO PERMIT NO. 14-1-135
MARINE CORPS AIR STATION, EL TORO

1. MCAS, El Toro is required to continuously monitor and record at the wastewater monitoring station located east of Bee Canyon Wash for flow, pH, and electrical conductivity.

2. MCAS, El Toro is required to install water meters where needed to measure non-domestic flows. Water meters shall be read monthly.

3. The flow, pH, and electrical conductivity meters are to be serviced weekly and calibrated semi-annually, or as needed to maintain accuracy. Service and calibration records shall be made available upon request.

4. The maximum permitted flow from MCAS, El Toro shall be 1.5 MGD as stipulated in the service agreement between MCAS, El Toro and IRWD.

5. Monthly, a flow weighted 24-hour composite sample shall be taken at the industrial waste monitoring station and analyzed for BOD, suspended solids, pH, and electrical conductivity. A sample shall be taken every 15 minutes and 4 samples shall be composited into a single bottle, for a total of 96 samples in 24 bottles. Electrical conductivity and pH shall be measured for each bottle. Suspended solids and BOD analyses shall be performed on the flow weighted composite sample.

6. Monthly, a grab sample shall be taken at the wastewater monitoring station and analyzed for oil and grease.

7. Semi-annually, the sewage flowing through the wastewater monitoring station shall be sampled for Total Toxic Organics (TTO) according to EPA method 624/625. The list of TTO and their method of analysis is shown in Attachment B.

8. Semi-annually, the industrial wastewaters pumped from the Bee Canyon Wash and Agua Chinon Wash pretreatment stations shall be sampled for TTO according to EPA method 624/625. The list of TTO and their method of analysis is shown in Attachment B.

9. The TTO samples will be collected and analyzed according to the CSDOC Standard TTO monitoring program.

10. No limit shall be set on the electrical conductivity. This constituent will be used by IRWD as a guideline to determine the total dissolved solids discharged by MCAS, El Toro.

11. No limit shall be set on the BOD and suspended solids. If the measurements exceed 300 mg/l BOD or 375 mg/l suspended solids, the treatment cost of the excess mass of these constituents will be charged to MCAS, El Toro in accordance with the IRWD Rules and Regulations.

12. Monthly, a grab sample shall be collected at both the Bee Canyon Wash and Agua Chinon Wash pretreatment stations from the pump going directly to the sewer and analyzed for oil and grease.

13. Monthly, flows from both the Bee Canyon Wash and Agua Chinon Wash pretreatment stations shall be estimated based on the pump output and the elapsed running time of the pumps. The maximum permitted flow shall be 72,000 gallons per day which equates to both pumps running continuously.

14. The following table summarizes the above information. The MCAS, El Toro shall observe the following discharge limitations:

Constituent	Maximum Limitation mg/L	MGD
Flow[1]	-	1.5
pH[2]	-	-
Electrical Conductivity	-	-
BOD[3]	300	-
Suspended Solids[3]	375	-
Oil and Grease	100	-
Sum of EPA 624 & 625	0.58	-

[1] See point 4 of Attachment A
[2] See the first page of the permit
[3] See point #11 of Attachment A

15. The following table summarizes sampling parameters:

A) Monitoring Station Effluent Monitoring

Constituent	Units	Type of Sample	Analyze Bottle	Analyze Comp.	Minimum Frequency Analysis
Flow	MGD	-	-	-	Continuous
pH	-	-	-	-	Continuous
Electrical Conductivity	µmho/cm	-	-	-	Continuous
BOD	mg/L	24-hr composite	No	Yes	Monthly
Suspended Solids	mg/L	24-hr composite	No	Yes	Monthly
pH	mg/L	24-hr composite	Yes	Yes	Monthly
Electrical Conductivity	µmho/cm	24-hr composite	Yes	Yes	Monthly
Oil and Grease	mg/L	Grab	-	-	Monthly
EPA 624	mg/L	Grab (4-a day)[2]	-	-	Semi-annual
EPA 625	mg/L	24-hr composite	-	Yes	Semi-annual

B) Bee Canyon Wash and Agua Chinon Wash Effluents Monitoring

Constituent	Units	Type of Sample	Analyze Bottle	Analyze Comp.	Minimum Frequency Analysis
Flow	gpd	-	-	-	Monthly
Oil and Grease	mg/L	Grab	-	-	Monthly
EPA 624	mg/L	Grab (4-a day)[2]	-	-	Semi-annual
EPA 625	mg/L	24-hr composite	-	Yes	Semi-annual

C) Non-Domestic Flows

Constituent	Units	Type of Sample	Analyze Bottle	Analyze Comp.	Minimum Frequency Analysis
Flow	Gal or cu.ft.	-	-	-	Monthly

[2]Four grab samples will be collected within a 24 hour period and will be composited by the laboratory at the time of analysis.

16. A monthly report containing this information is to be mailed to both CSDOC and IRWD and is due the first day of the second month following the month in which the samples were collected. (For example, the July sample results are due on September 1, 1989).

17. MCAS, El Toro agrees that it is bound by and is subject to all the provisions of the District's Ordinance as presently in effect or as may be amended from time to time hereafter during the term of this permit. The provisions of the ordinance shall be governing.

18. Nothing in this Attachment "A" shall prevent the District from enforcing the conditions, limitations, and requirements set forth in its Ordinance, or pursuing any of the enforcement actions authorized thereunder.

[signature]	Admin Officer Facilities Mgmt Dept.	5/3/90
Authorized Company Official	Title	Date
[signature]	Source Control Manager	20 June 90
Authorized CSDOC Official	Title	Date

CP:on
Attach.mar
4/9/90

ATTACHMENT "B"
TO PERMIT NO. 14-1-135
MARINE CORPS AIR STATION, EL TORO

Pesticides (625)

Aldrin
Chlordane
Dieldrin
4,4' - DDT
4,4' - DDE
4,4' - DDD
Alpha Endosulfan
Beta Endosulfan
Endosulfan Sulfate
Endrin
Endrin Aldehyde
Heptachlor
Heptachlor Epoxide
Alpha BHC
Beta BHC
Gamma BHC
Delta BHC
Toxaphene
PCB 1016
PCB 1221
PCB 1232
PCB 1242
PCB 1248
PCB 1254
PCB 1260

Base/Neutral Extractibles (625)

Acenaphthene
Benzidine
1,2,4, - Trichlorobenzene
Hexachlorbenzene
Hexachloroethane
Bis (2-Chloroethyl) Ether
2 - Chloronaphthalene
1,2 - Dichlorobenzene
1,3 - Dichlorobenzene
1,4 - Dichlorobenzene
3,3'- Dichlorobenzidine
2,4 - Dinitrotoluene
2,6 - Dinitrotoluene
1,2 - Diphenylydrazine
Fluoranthene
4 - Chlorophenyl Phenyl Ether
4 - Bromophenyl Phenyl Ether
Bis (2 - Chloroisopropyl) Ether
Bis (2 - Chloroethoxy) Methane
Hexachlorobutadiene
Hexachlorocyclopentadiene
Isophorone
Naphthalene
Nitrobenzene
N - Nitrosodimethylamine
N - Nitrosodi - N -Propylamine
N - Nitrosodiphenylamine
Bis (2 - Ethylhexyl) Phthalate
Butyl Benzyl Phthalate
Di - N - Butyl Phthalate
Di - N - Octyl Phthalate
Diethyl Phthalate
Dimethyl Phthalate
Benzo (A) Anthracene
Benzo (A) Pyrene
Benzo (B) Floranthene
Benzo (K) Floranthene
Chrysene
Acenaphthylene
Anthracene
1,12 - Benzoperylene
Fluorene
Phenanthrene
1,2,5,6 - Dibenzanthracene
Indeno (1,2,3, - CD) Pyrene
Pyrene
TCDO

Acid Extractibles (625)

2,4,6 - Trichlorophenol
P - Chloro - M - Cresol
2 - Chlorophenol
2,4 - Dichlorophenol
2,4 - Dimethylphenol
2 - Nitrophenol
4 - Nitrophenol
2,4 - Dinitrophenol
4,6 - Dinitro -O-Cresol
Pentachlorophenol
Phenol

Volatile Organics (624)

Acrolein
Acrylonitrile
Benzene
Carbon Tetrachloride
Chlorobenzene
1,2 - Dichloroethane
1,1,1 - Trichloroethane
1,1 - Dichloroethane
1,1,2 - Trichloroethane
1,1,2,2 - Tetrachloroethane
Chloroethane
Chloroform
1,1 - Dichloroethylene
1,2 - Trans Dichloroethylene
1,2 - Dichloropropane
1,2 - Dichloropropylene
Ethylbenzene
Methylene Chloride
Methyl Chloride
Methyl Bromide
Bromoform
Bromodichloromethane
Trichlorofluoromethane
Dichlorodifluoromethane
Dibromochloromethane
Tetrachloroethylene
Toluene
Trichloroethylene
Vinyl Chloride
Bis (chloromethyl) Ether
2 - Chloroethyl Vinyl Ether

COUNTY SANITATION DISTRI
of ORANGE COUNTY, CALIFORNI

10844 ELLIS AVENUE
P.O. BOX 8127
FOUNTAIN VALLEY, CALIFORNIA 92728-
(714) 962-2411

August 2, 1989
REF #991292.LTR

Attachment "A" to Permit No. 14-1-135
Marine Corps Air Station, El Toro

1. MCAS, El Toro is required to continuously monitor and record at the wastewater monitoring station located east of Bee Canyon Wash for flow, pH, and electrical conductivity.

2. MCAS, El Toro is required to install water meters where needed to measure non-domestic flows. Water meters shall be read monthly.

3. The flow, pH, and electrical conductivity meters are to be serviced weekly and calibrated semi-annually, or as needed to maintain accuracy. Service and calibration records shall be made available upon request.

4. The maximum permitted flow from MCAS, El Toro shall be 1.5 MGD as stipulated in the service agreement between MCAS, El Toro and IRWD.

5. Monthly, a flow weighted 24-hour composite sample shall be taken at the industrial waste monitoring station and analyzed for BOD, suspended solids, pH, and electrical conductivity. A sample shall be taken every 15 minutes and 4 samples shall be composited into a single bottle, for a total of 96 samples in 24 bottles. Electrical conductivity and pH shall be measured for each bottle. Suspended solids and BOD analyses shall be performed on the flow weighted composite sample.

6. Monthly, a grab sample shall be taken at the wastewater monitoring station and analyzed for oil and grease.

7. Semi-annually, the sewage flowing through the wastewater monitoring station shall be sampled for Total Toxic Organics (TTO) according to EPA method 624/625. The list of TTO and their method of analysis is shown in Attachment B.

8. Semi-annually, the industrial wastewaters pumped from the Bee Canyon Wash and Agua Chinon Wash pretreatment stations shall be sampled for TTO according to EPA method 624/625. The list of TTO and their method of analysis is shown in Attachment B.

9. The TTO samples will be collected and analyzed according to the CSDOC Standard TTO monitoring program.

10. No limit shall be set on the electrical conductivity. This constituent will be used by IRWD as a guideline to determine the total dissolved solids discharged by MCAS, El Toro.

11. No limit shall be set on the BOD and suspended solids. If the measurements exceed 300 mg/l BOD or 375 mg/l suspended solids, the treatment cost of the excess mass of these constituents will be charged to MCAS, El Toro in accordance with the IRWD Rules and Regulations.

12. Monthly, a grab sample shall be collected at both the Bee Canyon Wash and Agua Chinon Wash pretreatment stations from the pump going directly to the sewer and analyzed for oil and grease.

13. Monthly, flows from both the Bee Canyon Wash and Agua Chinon Wash pretreatment stations shall be estimated based on the pump output and the elapsed running time of the pumps. The maximum permitted flow shall be 72,000 gallons per day which equates to both pumps running continuously.

14. The following table summarizes the above information. The MCAS, El Toro shall observe the following discharge limitations:

Constituent	Maximum Limitation mg/L	MGD
Flow[1]	-	1.5
pH[2]	-	-
Electrical Conductivity	-	-
BOD[3]	300	-
Suspended Solids[3]	375	-
Oil and Grease	100	-
Sum of EPA 624 & 625	0.58	-

(1) See point 4 of Attachment A
(2) See the first page of the permit
(3) See point #11 of Attachment A

August 2, 1989
REF #991292.LTR

15. The following table summarizes sampling parameters:

A) Monitoring Station Effluent Monitoring

Constituent	Units	Type of Sample	Analyze Bottle	Analyze Comp.	Minimum Frequency Analysis
Flow	MGD	-	-	-	Continuous
pH	-	-	-	-	Continuous
Electrical Conductivity	μmho/cm	-	-	-	Continuous
BOD	mg/L	24-hr composite	No	Yes	Monthly
Suspended Solids	mg/L	24-hr composite	No	Yes	Monthly
pH	mg/L	24-hr composite	Yes	Yes	Monthly
Electrical Conductivity	μmho/cm	24-hr composite	Yes	Yes	Monthly
Oil and Grease	mg/L	Grab	-	-	Monthly
EPA 624	mg/L	Grab (4-a day)(2)	-	-	Semi-annual
EPA 625	mg/L	24-hr composite	-	Yes	Semi-annual

B) Bee Canyon Wash and Agua Chinon Wash Effluents Monitoring

Constituent	Units	Type of Sample	Analyze Bottle	Analyze Comp.	Minimum Frequency Analysis
Flow	gpd	-	-	-	Monthly
Oil and Grease	mg/L	Grab	-	-	Monthly
EPA 624	mg/L	Grab (4-a day)(2)	-	-	Semi-annual
EPA 625	mg/L	24-hr composite	-	Yes	Semi-annual

C) Non-Domestic Flows

Constituent	Units	Type of Sample	Analyze Bottle	Analyze Comp.	Minimum Frequency Analysis
Flow	Gal or cu.ft.	-	-	-	Monthly

(2) Four grab samples will be collected within a 24 hour period and will be composited by the laboratory at the time of analysis.

16. A monthly report containing this information is to be mailed to both CSDOC and IRWD and is due the first day of the second month following the month in which the samples were collected. (For example, the July sample results are due on September 1, 1989).

17. MCAS, El Toro agrees that it is bound by and is subject to all the provisions of the District's Ordinance as presently in effect or as may be amended from time to time hereafter during the term of this permit. The provisions of the ordinance shall be governing.

18. Nothing in this Attachment "A" shall prevent the District from enforcing the conditions, limitations, and requirements set forth in its Ordinance, or pursuing any of the enforcement actions authorized thereunder.

Michael Lemons	M. LEMONS, Administrative Officer Facilities Management Department By direction of the Commanding General	2 2 AUG 1989
Authorized Company Official	Title	Date
Richard W. von Langen	Source Control Manager	1 Sept 89
Authorized CSDOC Official	Title	Date

CP:on

Attachment "B" to Permit No. 14-1-135
Marine Corps Air Station, El Toro

Pesticides (625)

Aldrin
Chlordane
Dieldrin
4,4' - DDT
4,4' - DDE
4,4' - DDD
Alpha Endosulfan
Beta Endosulfan
Endosulfan Sulfate
Endrin
Endrin Aldehyde
Heptachlor
Heptachlor Epoxide
Alpha BHC
Beta BHC
Gamma BHC
Delta BHC
Toxaphene
PCB 1016
PCB 1221
PCB 1232
PCB 1242
PCB 1248
PCB 1254
PCB 1260

Base/Neutral Extractibles (625)

Acenaphthene
Benzidine
1,2,4, - Trichlorobenzene
Hexachlorbenzene
Hexachloroethane
Bis (2-Chloroethyl) Ether
2 - Chloronaphthalene
1,2 - Dichlorobenzene
1,3 - Dichlorobenzene
1,4 - Dichlorobenzene
3,3'- Dichlorobenzidine
2,4 - Dinitrotoluene
2,6 - Dinitrotoluene
1,2 - Diphenylydrazine
Fluoranthene
4 - Chlorophenyl Phenyl Ether
4 - Bromophenyl Phenyl Ether
Bis (2 - Chloroisopropyl) Ether
Bis (2 - Chloroethoxy) Methane
Hexachlorobutadiene
Hexachlorocyclopentadiene
Isophorone
Naphthalene
Nitrobenzene
N - Nitrosodimethylamine
N - Nitrosodi - N -Propylamine
N - Nitrosodiphenylamine
Bis (2 - Ethylhexyl) Phthalate
Butyl Benzyl Phthalate
Di - N - Butyl Phthalate
Di - N - Octyl Phthalate
Diethyl Phthalate
Dimethyl Phthalate
Benzo (A) Anthracene
Benzo (A) Pyrene
Benzo (B) Floranthene
Benzo (K) Floranthene
Chrysene
Acenaphthylene
Anthracene
1,12 - Benzoperylene
Fluorene
Phenanthrene
1,2,5,6 - Dibenzanthracene
Indeno (1,2,3, - CD) Pyrene
Pyrene
TCDO

Acid Extractibles (625)

2,4,6 - Trichlorophenol
P - Chloro - M - Cresol
2 - Chlorophenol
2,4 - Dichlorophenol
2,4 - Dimethylphenol
2 - Nitrophenol
4 - Nitrophenol
2,4 - Dinitrophenol
4,6 - Dinitro -O-Cresol
Pentachlorophenol
Phenol

Volatile Organics (624)

Acrolein
Acrylonitrile
Benzene
Carbon Tetrachloride
Chlorobenzene
1,2 - Dichloroethane
1,1,1 - Trichloroethane
1,1 - Dichloroethane
1,1,2 - Trichloroethane
1,1,2,2 - Tetrachloroethane
Chloroethane
Chloroform
1,1 - Dichloroethylene
1,2 - Trans Dichloroethylene
1,2 - Dichloropropane
1,2 - Dichloropropylene
Ethylbenzene
Methylene Chloride
Methyl Chloride
Methyl Bromide
Bromoform
Bromodichloromethane
Trichlorofluoromethane
Dichlorodifluoromethane
Dibromochloromethane
Tetrachloroethylene
Toluene
Trichloroethylene
Vinyl Chloride
Bis (chloromethyl) Ether
2 - Chloroethyl Vinyl Ether

APPENDIX V

CALCULATION WORKSHEETS

PES Environmental, Inc. Engineering & Environmental Services	PROJECT OF
	JOB NO.
	FILE NAME
PROJECT	COMPUTED BY DATE
SUBJECT	CHECKED BY DATE

Determination of Maximum Flow

Line Number	Internal VCP Cross Sectional Area (ft^2)	Maximum Flow Rate (gpm)
1	0.349	313.28
2	0.349	313.28
3	0.349	313.28
4	1.767	1,586.17
5	0.785	704.66
Total		**3,230.67**

Assumptions:

- Water Temperature: 60°F
- No Pipe Fittings
- Minimum Flow Velocity: 2 feet per second
- Conversion Factors: 7.4805 gallons per ft^3
  60 sec per minute

PES Environmental, Inc.
Engineering & Environmental Services

PROJECT	PROJECT OF
	JOB NO.
	FILE NAME
PROJECT	COMPUTED BY DATE
SUBJECT	CHECKED BY DATE

Determination of Rate of Exfiltration
Using Methodology From
Standard Specifications For Public Construction Projects

Quadrant	Total VCP Length (ft) L	Weighted Average Inner Diameter (in) D	Differential Head (ft) H	Max Allowable Exfiltration Rate (gpm) E
NW	61,825	8.66	5	119.7
NE	20,610	7.41	5	34.1
SE	20,475	8.09	5	37.0
SW	36,310	9.98	5	81.0
TOTAL				271.8

Assumptions:
- Differential Head Within Each Quadrant: 5 ft
- All VCP jointed with cement mortar.
- Formulae per Section 306-1.4.2, "Standard Specifications for Public Works Construction":

$$E = 000.1 \times L \times D \times \sqrt{5}$$

Where:
E: Maximum allowable rate of exfiltration
L: Length of VCP section in feet
D: Weighted average VCP inner diameter in square inches
H: Differential head in feet of elevation between inlet and outlet

Determination of Rate of Exfiltration Using Methodology From Appendix OII-C, Draft Final Phase II Remdial Investigation Operable Unit 2A – Site 24

Quadrant	Weighted Average Diameter of VCP (in) D	Length of VCP (ft)[1] L	Leakage Rate (gpm) Q_L
NW	8.66	61,825	97.5
NE	7.41	20,610	27.8
SE	8.09	20,475	30.2
SW	9.98	36,310	65.0
Total			220.5

Assumptions:

- 365 days per year, 24 hours per day
- Width of VCP joint: 0.5 to 1.5 inches; 0.9 inches used as weight average
- Vertical hydraulic conductivity of underlying material (K_V): 15 feet/day
- Vertical hydraulic gradient across VCP joint: 1.0
- Length of VCP barrel: 40 inches (1.11 feet)
- Engineering Formulae:

$$Q_L = D \times W \times K_V \times i_V \times \frac{L}{S}$$

Where:

Q_L: Leakage rate through the entire pipe segment
D: Diameter of pipe
W: Width of the pipe joint
K_V: Vertical hydraulic conductivity of the underlying material
i_V: Vertical hydraulic gradient across the joint
L: Total length of the pipe
S: Spacing between the adjacent joints

Determination of Aircraft Wash Area Availability

Time Period	Number of Year	A Percent of Total Time	B No. Wash Areas In NW, NE, SE Quads Over No. Total Wash Areas Available	Total Percent Wash Areas Availabile In NW, NE, SE (A x B)
1943 to 1973	29	57	9/12 or 75%	**42.8**
1973 to 1996	22	43	10/11 or 91%	**39.1**
Total	**51**	**100**		**81.9**

Determination of Vehicle Wash Rack Availability

Time Period	Number of Year	A Percent of Total Time	B No. Wash Areas In NW, NE, SE Quads Over No. Total Wash Areas Available	Total Percent Wash Areas Availabile In NW, NE, SE (A x B)
1943 to 1973	29	57	6/9 or 67%	**37.9**
1973 to 1996	22	43	19/28 or 68%	**29.2**
Total	**51**	**100**		**67.1**
Assume one third of the wash racks in the NW, NE, or SE Quads are operating:				**22.4**

Determination of Solvent "Mileage"
MCAS El Toro Dry Cleaning Plant

Years of Operation	No. of Years of Operation	Average No. of Personnel or Attached per Year	Weight Percent	Weighted Average No. Personnel
1943 to 1945	3	15,470	0.107	1,655
1946 to 1960	14	4,000	0.500	2,000
1961 to 1972	11	8,600	0.393	3,380
Total	28	28,070	1.00	7,035

Loads per marine assigned/attached per week:	1
Pounds per load:	5
@ 4.3 weeks per month, Total Pounds per month:	151,253
@ 12 months per year, Total pounds per year:	1,815,030
@ 300 pounds per gal of Solvent: Total gal solvent per year:	**5,500**

APPENDIX W

REPORT
AVIATION INFORMATION RESEARCH CORPORATION

AVIATION
INFORMATION
RESEARCH
CORPORATION

27 September 1999

Paul E. La Bonte
PES Environmental, Inc.
203- E. Fourth Street, Suite 213
Santa Ana, California 92705-3920

Dear Mr. La Bonte,

Attached is our report titled, MCAS EL TORO, AIRCRAFT ASSIGNED BY YEAR 1946 - 1985 (See TAB-1). This data was obtained by Aviation Information Research Corporation (AIRC) using "OPNAV U.S. Navy's Monthly Status Of Naval Aircraft" reports, "OPNAV Location Of Naval Aircraft" reports, and "Allowances and Location Of Naval Aircraft-OPNAV Notice C3110", which are on file at the U.S. Navy's Aeronautical Archives located at the Washington Navy Yard, Washington, D.C.

As I mentioned in our fax dated 23 September 1999, the Navy documents list total aircraft inventory at each base by unit/squadron. In order to break down this total number of aircraft by type, AIRC conducted a manual count through each and every page of the selected monthly reports. Having completed this, we noticed that the total numbers of individual aircraft assigned by type, rarely match the total number of aircraft assigned to El Toro as published by the Navy. Possible reasons why these numbers do not match include:

- Poor quality control of initial count by the Navy
- The Navy changed their reporting formats and schedules several times over the time-frame of this study.
- AIRC could not locate data on all of the individual types of aircraft for the units assigned to El Toro.

Notes:
1- AIRC has gone back to the Navy Yard and reviewed at least eight individual reports and although we were able to adjust some numbers, we were unable to achieve an exact match-up between the number of individual aircraft listed and the Navy's total figures given for El Toro.
2- If PES requires exact correlation between the numbers of each type of aircraft assigned and the total number of aircraft assigned to El Toro, AIRC is willing to return to the Navy Yard, one more time to attempt to clarify the numbers.

The U. S. Marine Historical Center (MHC), which is also located at the Washington Navy Yard, holds a collection of unit history reports titled: Command Chronology. The

73 FENDALL AVE., ALEXANDRIA, VIRGINIA 22304 • PHONE: (703) 823-1264 (VOICE & FAX)
INTERNET: tcairc@avinforsch.com CIS: 72233,55 AOL: TCAVIATION

MHC has copies of these (semi-annual) reports from MCAS El Toro beginning in 1965 and running through the 1990's. I have enclosed one copy for your review (See TAB-2). These Command Chronology reports typically contain information on:

- Staff Positions
- Name/Rank of key positrons
- Average monthly strength (manning)
- Sequential listing of significant events
- Public works projects/contracts
- Others

Additionally, The MHC holds semi-annual Command Chronology reports from the different units/squadrons that were stationed at El Toro after 1965. For example, from the records we can determine that the unit, VMFA 314 was at El Toro in 1982. Thus, there should be Command Chronology reports from this unit in the MHC archives. We are prepared to continue the search for data at the MHC if you desire. Please advise.

See TAB-3 for the intro pages from several OPNAV reports. These contain interesting information, including a list of abbreviations and a listing of Naval Aircraft Classes and Sub-Classes and Aircraft Model Numbers, etc. used in the reports.

I have also taken the liberty to include several other historical documents that I thought you would be interested in seeing. See TAB-4 for the following listed documents:

- El Toro Bi-Monthly News Letter for Period March 15-31 Dated, April 5, 1943.
- MCAS El Toro History, 5 February 1947.
  - -- Aircraft Engineering excerpt only.
- MCAS El Toro History, 12 May 1947.
  - -- Aircraft Engineering excerpt only.
- MCAS El Toro History, 4 February 1953.
  - -- WMD-1 and Operations excerpts Appendix One.
- MCAS El Toro List of Commanding Officers through July 1949.
- MCAS El Toro Special Use Permit Letter, 14 October 1956.
- Naval Aviation News article, "1943 El Toro 1958. Date, March 1958.
- MCAS El Toro Press Release Construction, Date, Unknown
- MCAS El Toro "El Toro Facts 5-5-5, Date, Unknown

We have enjoyed working on this project and hope we can be of further assistance to PES. A Billing Statement (next under) is presented for our work accomplished to date.

Sincerely,

Thomas M. Culbert

Attachments: a/s

MCAS EL TORO
AIRCRAFT ASSIGNED BY YEAR 1946 - 1985

( ) = Total number of aircraft assigned to MCAS El Toro by unit/squadron - all types of aircraft included.

1946	**1947**	**1948**	**1949**	**1950**	**1951**	**1952-A**
January	January	January	February	January	January	December'51
(219)	(292)	(287)	(271)	(232)	(147)	(308)
TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#
FG-33	F4U-192	F7F-18	F4U-115	F4F-2	F4U-89	F4U-135
F4U-68	R5D-30	F6F-23	TO-15	OY-1	R5D-15	F3D-12
TBM-60	JRB-9	SNB-6	SNJ-30	R4D-11	R4D-9	F7F-12
SB2C-1	SNB-2	F4U-207	F6F-24	JRB-4	F7F-2	AD-10
R4D-1	R4D-8	SNJ-17	SNB-8	SNB-13	TBM-2	F6F-26
JRB-1	OY-1	R4D-3	F7F-19	SNJ-3	SNB-16	R4D-55
J2F-1	SNJ-22	R5D-13	R5D-17	F7F-8	F6F-2	JRB-4
GB-4	F7F-13		R4D-8	R5D-30	P2V-1	SNB-27
GH-5	F2T-6		TBM-4	F4U-130	TO-1	R5D-2
SNJ-3	F6F-5		JRB-1	TBM-4	SNJ-5	F8F-15
N2S-2			JD-1	TO-13	JRB-5	OE-1
PBJ-1			PV2-1			SMK-15
R3D-2			OY-1			TO-3
R5D-1						
JM-24						
SNB-2						
F6F-1						
F3A-5						
F7F-1						
NE-2						
LNS-1						

Continued -

( ) = Total number of aircraft assigned to MCAS El Toro by unit - all types of aircraft included.

1952-B	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**
December	December	December	December	December	December	January '59
(240)	(209)	(228)	(333)	(288)	(274)	(302)
TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#
AD-22	F2-26	F9F-110	F9F-185	F9F124	F4D-40	FJ-28
F9F-49	F9F-34	AD-22	AD-24	AD-18	F9F-65	A4D-41
SNJ-1	FJ-17	R5D-21	R4D-47	SNB-8	F3D-35	R4D-24
F3D-15	F3-28	R4D-13	TV-20	FJ-24	FJ-27	TV-13
F7F-15	AD-14	SNB-11	HO3-2	R4D-9	AD-16	F9F-38
F4U-27	R4D-15	F7F-2	OE-5	HUP-2	T28-6	F4D-45
FG-23	TV-15	JRB-5	R5D-34	F3D-27	F2H-3	R5D-25
RD5-12	SNB-11	SNB-5	SNB-11	OE-2	R5D-31	SNB-7
TV-11	OY-4	SNJ-1	F3D-27	R5D-30	R4D-28	F8U-58
R4D-24	F4U-4	HO35-2	T28-5	HOK-1	TV-11	F3D-11
JRB-4	F7F-3	TV-13	JRB-5	F4D-14	SNB-10	HOK-12
SNB-17	JRB-4	F3D-27	SNJ-1	SNJ-1	JRB-2	HRS-13
F6F-13	SNJ-1		HUP-2	A4D-1	HUP-2	HR2S-9
OY-1	TBM-2			T28-6		T28-1
				TV-32		JRB-1
				F2H-3		
				JRB-4		

Continued -

( ) = Total number of aircraft assigned to MCAS El Toro by unit - all types of aircraft included.

1959	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**
December	December	December	December	December	December	December
(285)	(309)	(284)	(140)	(279)	(264)	(144)
TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#
F4D-25	R4D-10	A4-60	C54-4	C117-6	A4-8	F4B-15
A4-42	F9F-10	F8U-54	C117-6	C47-5	C47-2	F8-14
R4D-14	R5D-11	F3D-10	C47-5	T1A-11	T1A-5	A4-17
F9F-6	SNB-7	GV-6	T1A-12	T28-4	F8-33	KC130-10
FJ4B-17	F8U-83	HUS-29	F8-53	A4-55	F4B-22	C131-1
R5D-18	F4D-40	FJ4B-1	F4B-23	F8-42	EF10B-12	C117-2
TV-9	A4-68	R4D-7	A4-59	F4B-16	KC130-12	UH34D-2
SNB-5	FJ4B-21	F9F-31	EF10B-11	EF10B-12	UH34D-30	T33-3
F8U-62	F3D-9	R5D-3	KC130-16	KC130-13	C54-1	UC45J-2
F3D-9	TV-1	T2V-11	UH34D-26	UH34D-31	C131-1	
HOK-12	HRS-11	F4D-33	C131-1	C54-2	C117-4	
HRS-13	HUS-7		TC45J-4	CH19-2	UC45J-4	
			U11A-1	TC45J-4	U11-1	
			T33-2	U11-1	T33-3	
			C19E-2	T33-3	CH19-1	
			F6A-9		RF8-1	

Continued -

( ) = Total number of aircraft assigned to MCAS El Toro by unit - all types of aircraft included.

1966	**1967**	**1968**	**1969**	**1970**	**1971**	**1972**
December	December	December	December	December	**No Data**	December
(97)	(112)	(101)	(101)	(129)		(113)
TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#
F4-12	F4-27	F4-33	F4-15	F4-30		F4-19
F8-13	A4-13	A4-22	A4-22	A4-36		KC130-10
C131-1	KC130-23	KC130-9	KC130-12	A6A-2		RF4B-7
C117-2	RF4-11	TA4F-5	RF4-8	KC130-9		EA6A-5
U11-1	EF10B-7	C131-1	EF10B-12	RF4B-9		C117-9
T33-2	C54-1	C117-2	C54-1	C54-2		A10-2
UC45J-2	C117-2	U11-1	C117-4	C117-6		A1-6
CH19-2	C47-2	US2B-1	C47-3	TA4F-4		C131-1
KC130-17	T1A-8	US2A-1	TA4F-6	C131-1		T28-2
	T-33-2	T33-2	C131-1	US2B-2		HH1K-1
		UH34D-2	U11-1	T33-2		T34-1
			US2B-1	T28-3		
			T33-2	UH34D-2		
			U34D-2	HH1K-2		
				T34-1		

Continued -

( ) = Total number of aircraft assigned to MCAS El Toro by unit - all types of aircraft included.

1973	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**
December	December	December	**No Data**	March	March	March
(148)	(122)	(147)		(171)	(106)	(149)
TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#
F4-31	F4-18	F4-45		F4-22	F4-11	U3-1
A4-16	A4-36	A4-25		A4-63	A4-12	A4-37
A6A-7	RF4B-8	A6A-6		A6A-12	A6-27	CH46-9
KC130-13	EA6A-5	KC130-14		KC130-12	KC130-10	RF4B-17
RF4B-8	C117-5	C117-6		RF4-16	RF4B-13	KC130-13
EA6A-4	TA4F-4	TA4F-6		C117-6	TA4F-8	F4-34
C117-9	C131-2	C131-1		TA4F-8	CJ46-8	A6E-20
A10-3	T39-1	T33-2		T-39-2		
A1-2	T28-4	T28-3		T28-1		
C131-1	HH1K-3	HH1K-2		UH1N-3		
T-28-3	OV10A-6	UH1N-1		CH46-12		
HH1K-4	AH16-6	OV10A-5				
	CH46-8	AH10-7				
	KC130-11	CH46-8				

Continued -

( ) = Total number of aircraft assigned to MCAS El Toro by unit - all types of aircraft included.

1980	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**
March (112)	March (184)	March (145)	March (143)	March (144)	March (162)	March (145)
TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#	TYPE-#
F4-10	F4-11	F4-31	FA18-7	FA18-35	FA18-26	FA18-15
A6E-16	A4-60	A4-27	A4-47	A4-28	A4-43	A4-45
A4-20	A6E-10	A6E-20	A6E-6	A6E-7	A6E-7	A6E-7
KC130-12	KC130-10	KC130-11	KC130-12	KC130-14	KC130-10	KC130-14
RF4B-14	RF4B-17	RF4-10	RF4-13	RF4-16	RF4-12	RF4-15
OA4-5	CA4M-8	CA4M-7	OA4-7	OA-6	OA4-6	OA4M-5
UC12B-1	UC12B-2	CT39-1	CH46-11	CT39-1	F4-5	CT39-1
T39-2	T39-2	UC12B-3	CT39-1	UC12B-1	CH46-13	UC12B-2
UH1N-3	UH1N-3	UH1N-3	UC12B-3	UH1N-3	CT39-1	UH1N-3
CH46-8	TA4J-1	TA4J-1	UH1N-3	CH46-13	UC12B-2	F4-6
U3A-1	CH46-7	CH46-9		T34-1	UH1N-3	CH46-11
					T34-1	T34-1

LAST ITEM

Notes:

1. Sources:
   - OPNAV Monthly Status of Naval Aircraft, Navy Department, Office of the Chief of Naval Operations
   - OPNAV Location Of Naval Aircraft, Navy Department, Office of the Chief of Naval Operations
   - Allowances and Location Of Naval Aircraft, OPNAV Notice C3110, Department of the Navy, Office Of The Chief of Naval Operations.
2. Reporting formats and schedules changed several times during the period included in this survey. The month of report used is stated under the year headings. Note there are two reports dated 1952 - one from 31 December 1951(A) and then December 1952(B).
3. Figures for the number of aircraft by type do not always add up to match the published total number of aircraft assigned ( ).

U. S. MARINE CORPS AIR STATION
EL TORO (SANTA ANA), CALIFORNIA

IN REPLY REFER TO:
25:JJL:ske
5213
7 MAR 1966

From: Commanding General
To: Commandant of the Marine Corps (Code (AO3D))

Subj: Command Chronology (Report Symbol MC-5750-6)

Ref: (a) MCO 5750.2

Encl: (1) MCAS El Toro Command Chronology

1. In accordance with reference (a), the Command Chronology for Marine Corps Air Station, El Toro (Santa Ana), California covering the period 1 Jul-31 Dec 1965 as contained in enclosure (1) is herewith submitted.

L. D. EVERTON
CHIEF OF STAFF

1. ORGANIZATIONAL DATA

a. Designation

Command and General Staff

Command Echelon

G-1 Echelon

Admin/Manpower Distribution Division
Clubs and Messes Division
Marine Corps Exchange Division
Postal Division
Special Services Division

G-2 Echelon

Inspection Division
Security Division
Structural Fire Protection Division

G-3 Echelon

G-4 Echelon

Comptroller Echelon

Accounting Division
Administrative Division
Budget Division
Disbursing Division

Special Staff

Adjutant
Air Base Development Officer
Area Auditor
Aviation Safety Officer
Chaplain
Food Services Officer
Informational Services Officer
Ground Safety Officer
Legal Officer

Departmental Staff

Aircraft Maintenance Department
Airfield Operations Department
Communications Department
Data Processing Department
Dental Department

Electronics Maintenance Department
Industrial Relations Department
Medical Department
Supply Department
Training Department
Weapons Department

Subordinate Commands

Headquarters and Headquarters Squadron, MCAS, El Toro (Santa Ana), California
Station Operations and Engineering Squadron, MCAS, El Toro (Santa Ana), California
Sub-Unit #1, MCALF, Camp Pendleton, California
Station Maintenance Squadron, MCAS, El Toro, (Santa Ana), California
Women Marine Detachment-1, MCAS, El Toro, (Santa Ana), California

Attachments

Naval Air Maintenance Detachment, MCAS, El Toro, (Santa Ana), California
Fleet Airborne Electronic Training Unit, Pacific, Marine Corps Air Station, El Toro (Santa Ana), California

b. Name/Rank of Commanding General and Staff including T/O billet assignment.

Commanding General
Major General Frank C. THARIN, USMC

Chief of Staff
Colonel Loren D. EVERTON, USMC
Assistant Chief of Staff, G-1
Lieutenant Colonel Lester MILLER, USMC 1-31Jul65
Colonel Harold A. EISELE, USMC 1Aug-31Dec65
Assistant Chief of Staff, G-2
Colonel George D. WOLVERTON, USMC
Assistant Chief of Staff, G-3
Colonel Harold A. EISELE 1-31Jul65
Colonel Martin B. ROUSH, USMC 1Aug-31Dec65
Assistant Chief of Staff, G-4
Colonel Elton MUELLER, USMC
Assistant Chief of Staff, G-5
Colonel Russel D. RUPP, USMC 10Aug-31Dec65, (Non T/O billet)
Comptroller
Major Joseph J. WENT, USMC
Area Auditor
Captain Frank FERRANTE, USMC

Chaplain
Commander James A. SULLIVAN, USN (CHC)
Aviation Safety Officer
Lieutenant Colonel William E. CULP, USMC 1Jul-18Dec65
Major James D. PIERCE, USMC 19-31Dec65
Legal Officer
Lieutenant Colonel Donald E. HOLBEN, USMC
Adjutant
Major Harry D. PERSONS, USMC
Information Service Officer
Captain Donald R. HUDSON, USMC 1Jul-6Aug65
1st Lieutenant Gale E. LAWSON, USMCR 7Aug-31Dec65
Air Bases Development Officer
Lieutenant Colonel Ernest J. BERGER, USMC
Medical Officer
Captain Edward A. JONES, USN (MC)
Dental Officer
Captain Harry B. MCINNIS, USN (DC)
Airfield Operations Officer
Lieutenant Colonel Harry R. MOORE, USMC
Communications Officer
Lieutenant Colonel Horace C. REIFEL, USMC
Electronics Maintenance Officer
Major Edward E. GREBENSTIEN, Jr., USMC
Training Officer
Major William P. GORSKI, USMC
Industrial Relations Officer
Mr. Billy G. LARGENT
Supply Officer
Captain John D. SMITH, USN (SC)
Public Works Officer
Captain Ferdinand W. ARNOLD, USN
Weapons Officer
1st Lieutenant Clive R. MECHAM, USMCR 1Jul-28Nov65
Chief Warrant Officer-3 Joseph V. VISMONT, USMC
1st Lieutenant Howard A. FRANZ, USMC 20-31Dec65
Aircraft Maintenance Officer
Chief Warrant Officer-4 John E. NEW, USMC
Data Processing Officer
Major Rudolf S. SUTTER, USMC 1-21Jul65
Captain Harry R. GENTRY, USMC 22Jul-31Dec65
CO, H&HS
Major Richard L. CRITZ, USMC 1-15Jul65
Lieutenant Colonel Donald L. HERRICK, 16Jul-31Dec65
CO, SOES
Lieutenant Colonel Benjamin G. MARTIN, USMC
CO, SMS
Major Vance L. YOUNT, USMC
CO, WMD-1
Captain Nannette L. BEAVERS, USMC
OinC, SU #1, SOES
Major Francis R. MURRAY, USMC

c. Average monthly strength during period.*

CHARGEABLE		
Marine Officer	93	
Navy Officer	36	
Marine Enlisted	890	
Navy Enlisted	97	
	1116	1116
ATTACHED		
Marine Officer	38	
Navy Officer	3	
Marine Enlisted	551	
Navy Enlisted	43	
	635	635
Military Sub Total		1751
CIVILIANS		
Appropriated	772	
Non-appropriated	412	
Civilian Sub-Total	1184	1184
TOTAL		2935

*Includes strengths of NAMTRADET and FAETUPAC

2. SEQUENTIAL LISTING OF SIGNIFICANT EVENTS.

a. Personnel

(1) In response to CG, MCAS, El Toro ltr 60:BRE:cah of 19Feb65 recommending establishment of an Air Freight and Passenger Service Man MOS, this command was notified by CMC ltr AOIB-mjc of 11Aug65, of a forthcoming change (No. 20) to MCO P1200.7(MOS Manual) establishing skill designators 3112 (Air Freight Operations Man) and 3122 (Air Freight Transportation Clerk). This action is in recognition of the fact that an experienced air freight and passenger service man is highly skilled and capable of performing a unique mission, for which previously no skill designator was authorized.

(2) On 20 Oct word was received from Headquarters that a Personnel Allocation change (612-65) effective 1Jan66 would provide an additional ten officers and three-hundred nineteen enlisted personnel to the command as augmentation in support of our Vietnam commitment.

(3) On 8Nov CG ltr 80:80:30:meh 1300 was drafted as a study for request of replacement of military personnel by Civil Service employees in the Motor Transport field. This letter, submitted to Division Southwest Bureau of Yards and Docks, was precipitated by a 56 man shortage in the transportation branch of the Public Works Department.

(4) A shortage of sufficient cooks necessitated closing Mess Hall #1 on 1Nov.

(5) In an effort to assist Vietnam returnees to get home for Christmas, Area Separation Branch processed over 700 personnel during the period 20-23 December.

b. Administration

(1) On 2Jul the remaining bodies of the Marines killed on 25Jun in the MATS crash at El Toro were shipped by the Medical Department to their final destinations.

(2) In preparation for the Inspector General's visit in January 1966, the G-2/Inspector conducted pre-IG inspections of all station squadrons and departments during the period 27Oct-24Nov65.

(3) Legal activity during the period consisted of the following: GCM - 4; SCM (BCD) - 6, (Non-BCD) - 22; SumCourt's-Martial - 16; and NJP - 214.

c. Training

(1) On 1Sept a new Basic Training program was inaugurated by StaO 1510.4L. Under the new system all training for MCAS is under the cognizance of the Training Department with each of the three squadrons providing instructor and supervisory personnel.

(2) In response to MCO 1510.10 the first special insurgency/counter-insurgency class was conducted by the Training Department. Forty personnel from Camp Pendleton; 3D Marine Aircraft Wing; MCAS, Yuma; MCAF, Santa Ana and MCAS, El Toro attended.

d. Special Projects

(1) Between 15Sep-30Oct65, campaign WOW (War on Waste) was conducted. Two-hundred twenty-six (226) suggestions were received. Fifty-nine (59) suggestions have been adopted (to date).

(2) CG, MCAS, El Toro ltr 60:BRE:gcf 5311 of 15Dec65, submitted a request for a major reorganization of this command. Enclosures (1) and (2) to the basic letter contain recommended Marine and Navy personnel staffing of two (2) subordinate units; specifically, no provision for the staffing of the present Station Maintenance Squadron or Women Marine Detachment-One was included. The two (2) squadron concept provides for the personnel of Headquarters and Headquarters Squadron to function under direction of the General Staff and Departmental levels

and comprises those units concerned with administrative personnel services, logistical and base maintenance support functions. It further provides for the Station Operations and Engineering Squadron commander to exercise line control of subordinate units rather than remain under control of the General Staff. Composition of Station Operations and Engineering Squadron comprises those units concerned with daily operational requirements of the Air Station. The General Staff will continue to exercise staff cognizance over all echelons relative to matters concerning plans and policies.

(3) During the months of October, November and December, the Marine Exchange at MCAS, El Toro participated in Operation Christmas Tree. This was a troop support project for the 3rd MAF stationed in the Republic of Vietnam. Working together with the Exchange at Camp Pendleton and MCRD San Diego, the Exchange was able to provide mail order services for the troops in the field to send Christmas presents to their families at home. This Exchange alone realized mail order sales of $26,483.55.

(4) On 19Aug65, Hill 733, an avigation obstruction underlying the jet A/C departure from RWY-7, was declared excess to the needs of the Department of Defense. Ref: SOWESTDOCKS ltr Ser. 10168/61.11 of 19Aug65 to GSA, Real Property Division, San Francisco. Subsequent to this action, the GSA advertised the material for sale; thus disposal of an avigation obstruction, which would cost over 2.5 million dollars, may be accomplished at no cost to the government.

e. Activations, deactivations and redesignations of units within the organization

(1) on 30Jun65, a Data Processing Department, directly responsible to the Chief of Staff, was formally established by Change 2 to StaO P5451.2D (Organization Manual). The Department is under the staff cognizance of the Comptroller. Data Processing functions were formerly performed at the Division level under the direct control of the Comptroller.

(2) On 1Aug65, by ABO 1746.25, a Central Services Agency was formally established to provide centralized accounting, collection, disbursing, procurement and reporting functions for non-appropriated clubs and messes facilities for MCAS, El Toro and MCAF Santa Ana. The Commandant of the Marine Corps approved the basic request contained in COMCABWEST ltr 60:JAK:cah over 7010 of 15Mar65 by CMC ltr DSQ-ded of 11May65. During the period 1Aug through 31Oct65, bookkeeping services only were offered. Commencing 1Nov, the full concept of the Central Services Agency operation, less closed messes, was undertaken. By higher directive, centralization of exchange

facilities is prohibited; however, the long range plan is to include the recreation funds of these installations within the scope of the Central Services Agency concept.

(3) By CMC ltr A01E-jms of 15Dec65, in response to CG, MCAS ltr 60:BRE:wsg Ser: 0015-65 of 29Oct65, the redesignation of this installation's Area Separation Center as a Separation and Draft Center and an increased personnel staffing for this facility was approved. The unit, in conjunction with Airfield Operations, provides complete processing services for transient personnel returning to CONUS from WESTPAC and those assigned to WESTPAC from CONUS-based commands. Transient personnel processed through this facility is in excess of two-thousand (2,000) men per month.

f. Community Relations

(1) In response to SECNAV msg 282332Z May 1965 and in support of the President's Youth Opportunity Program, this command employed twelve (12) underprivileged youths during the period 12Jun65 to 30Sep65. The program was well received by the civilian community and considered a success by this command.

(2) On 16Jul65, Mr. Ross CORTESE, President of Rossmoor Leisure World, and his counsel, Thomas R. SHERIDAN, visited the office of Mr. Edwin L. WEISL, Jr., Assistant Attorney General, Land Division of the Department of Justice. Purpose of the visit was to place the Department of Justice on notice that they were contemplating some sort of action in connection with difficulties encountered regarding the air station (MCAS El Toro), and to obtain an advisory opinion as to what the attitude of the Justice Department would be if they took action, e.g., claim the restrictions on the Leisure World property constituted some sort of "inverse condemnation". Ref: MEMO from Mr. Albert H. STEIN, Deputy General Counsel, Department of the Navy, OGC/AHS:mcb of 7Sep65, to the ASN(I&L), copy to CMC. Assistant Attorney General (E.L. WEISL, Jr.) ltr of 16Jul65 to General Counsel (M.H. STEGER) Department of the Navy.

(3) On 28Jul65, the Orange County Planning Commission, at a public hearing, approved the Moral Investment Company's plan for development of the area formerly known as Tract 4848.

(4) On 2Aug65, ASN(I&L) MEMO of 2Aug65, to Assistant Secretary of Defense (Legal Affairs) Subj: HOLF Mile Square; request by Orange County to Lease portion of, for park and recreational purposes, affirmed the need for a fair rental value of the property to be leased.

(5) On 1Sep65, the Orange County Board of Supervisors, during a public hearing, unanimously declared its intention to approve the Moral Investment Co. plan, contingent upon Moral's dismissing its $2,000,000 lawsuit against the county. The plan included the restriction of residential construction within 1500 ft. of the centerline of RWY-34R. Ref: COMCAB-WEST ltr 10:FCT:hjb of 3Sep65 to CMC.

(6) The Orange County Building and Construction Trades Council placed pickets at Gates 2 and 9 on 14Sep. The pickets carried placards stating that Schurr and Finlay, Inc. do not have a working agreement with the local Building and Constru-tion Trades Council. All construction work on the Station was temporarily interrupted-approximately $2,604,000 worth of military construction was effected. The Officer in Charge of Construction immediately posted signs at each Gate and directed the firm of Schurr and Finlay, Inc. to restrict the entrance of their employees to the Station through Gate 9. All other contractors were advised to use Gate 2. This action permitted most of the contractors to continue their work during the afternoon. The picketing continued for ten days, but did not affect the progress of construction after the first day.

(7) On 9Nov65, the Director, Southwest Division, Bureau of Yards and Docks, was authorized to negotiate a lease with Orange County for approximately 485 acres of HOLF Mile Square, for park and recreational purposes. Leasing of the property would be subject to agreement by the county to pay fair rental and to accept a twenty-five year lease term. Ref: CHBUDOCKS ltr 61.311/KLS:db of 9Nov65 to DIRSOWESTDOCKS.

(8) On 24Nov65, the Orange County Board of Supervisors approved the 6th Revised General Plan of Rossmoor Leisure World. Representatives of this command attended public hear-ing's on this plan and it was determined that proposed changes were in accord with the integrity of the "green belt".

(9) On 2Dec65, Supervisor BAKER, of the Orange County Board of Supervisors, was advised of SECNAV'S approval for leasing 485 acres of HOLF Mile Square to the county for park and recreational purposes, and the requirement for fair rental and a 25-year lease term. Mr. BAKER was requested to advise if the terms were satisfactory. Ref: SOWESTDOCKS ltr Ser. 16046/61 of 2Dec65.

(10) On 7Dec65, the Orange County Board of Supervisors adopted the 6th Revised General Plan of Rossmoor Leisure World as an ordinance (the plan was recorded and became effective on 6Jan66)

(11) On 20Dec65, representatives of the Irvine International Raceway met with MCAS El Toro staff officers to discuss the feasibility of constructing a one-quarter mile raceway (dragstrip), southwest of the air station on property to be leased from the Irvine Co.

(12) During the period covered by this report Major General THARIN participated in twenty-six separate community luncheons/receptions; made four speaking engagements at civic clubs in Orange County; and participated as a board member on seven different local committees and projects on a recurring basis.

(13) As a community service, back-up computer services are provided to the Orange County School District on a time-available basis. This service was afforded twice during the period of this report.

g. Ceremonies and Visits

(1) On 1Jul the Marine Corps Air Station and the 3d Marine Aircraft Wing joined forces in conducting a parade honoring Brig. General W.H.KLENKE, USMCR, on his retirement from the Marine Corps Reserve.

(2) During July and August the FSAO-7 Team inspected the Station Supply Department.

(3) The Marine Corps Drum and Bugle Corps and Silent Drill Team performed at a sunset parade on 19Oct. The ceremonies were witnessed by approximately 3500 personnel.

(4) On 25Oct. the Commandant of the Marine Corps visited El Toro and was briefed by the Commanding General and his staff. A reception was held in the Officer's Club in the evening.

(5) During the period 4-27Oct the West Coast Food Service Team visited Station Food Services facilities.

(6) On 10Nov, the Station and Wing combined in a parade to honor Admiral MELENDIZ, Chief of Naval Operations, Spanish Navy. The parade was followed by an outdoor version of the standard Marine Corps Birthday pagent, including a cake cutting.

h. Modifications to Plant and Facilities

(1) Commencing on 1Jul65, official allotment accounting records (NavCompt Form 2030) at El Toro became the product of a fully mechanized system in lieu of a previous manual posting operation using a NCR-33 bookkeeping machine.

(2) Commencing 1Jul65, and in accordance with SecNav 7323.7 of 13Apr65, the Financial Inventory Control Reporting Section was transferred from the Supply Department to the Comptroller. In assuming this additional function, the following responsibilities were also assumed by the Comptroller:

(a) Maintenance of financial inventory records.

(b) Initiating coordination action to resolve discrepancies on documents or listings received from other units, and performing follow-up action.

(c) Providing financial inventory data to the Supply Department and other components as necessary for effective inventory and financial management.

(d) Preparing and submitting financial inventory reports monthly.

(e) Serving as a focal point for all inquiries relating to financial inventory, records and reports.

(f) Providing and monitoring financial inventory systems furnished to the Data Processing Department.

(3) Contract NBy-63169, alterations to Mess Bldg 262, was completed on 2Jul. The contract was awarded on 24Feb65 to Simar, in the amount of $58,670.

(4) Contract NBy-63242, alterations to Bldg 54 (Station Brig) was completed on 8Jul. The contract was awarded on 8Mar65 to John WARD Company, in the amount of $20,459.

(5) Contract NBy-60241 for Rehabilitation of BOQ's and Barracks Bldg 327 (Women Marine Barracks) was awarded to Allied Mechanical contractors on 9Jul in the amount of $129,726. Progress on the work has been good, and it is expected that the project will be completed by 14Feb66.

(6) Contract NBy-57701, Runway End Zone Improvements, was awarded to Coxco, Inc. on 29Jul in the amount of $175,850. This project was scheduled to be completed by 20Jan66; however, heavy rains during the months of November and December have delayed the contractor. It is expected that the time will be extended to about 15Feb. During the course of construction it was determined that a right-of-way easement on property held by the University of California's Board of Regents was in error, and it was necessary to modify the agreement. This work was accomplished without delaying the project.

(7) On 29Jul65 a contract was awarded for improvement of runway end zones; $178,458. Project includes work on station as well as on adjacent county and private property, which was made possible by written agreements with the Irvine Company, Baker Properties and the University of California. Ref: NBy-57701 and MCON EP-44.

(8) Contract NBy-53532, Aircraft Maintenance Hangars 1 and 2, was completed on 18Aug. This project was awarded on 19Feb64 to Allison Honer Company in the amount of $1,046,245.

(9) Contract NBy-61444, additions to Bldg 56 and Bldg 1, was awarded to Mr. A.J. NYROOS on 24Aug in the amount of $20,249. The addition to Bldg 56 was required to house new aircraft trainer panels, and the addition to Bldg 1 was required to install equipment for the new CENTREX telephone facilities. Work was completed on 6Dec65.

(10) Contract NBy-61440, Handball Court Construction, was awarded to Mr. Don CRAIG on 24Aug in the amount of $19,912. This project was financed from Special Services Funds and will provide two reinforced concrete handball courts. The work was scheduled for completion 27Dec65; however due to heavy rains during November and December, work was delayed. It is expected that a time extension will be issued to extend the contract time to approximately 15Feb66.

(11) On 24Aug65, a contract was awarded for construction of 2,270 SF wood frame and siding addition to Bldg #56, for housing A-4E cockpit orientation and A/C Maintenance Training devices; $20249.00. Construction was completed on 6Dec65. Ref: NBy-57679.

(12) Modification to Telephone Exchange in Bldg #1 to accomodate CENTREX Telephone System commenced by contractor (Contract #NB76144) on 7Sep.

(13) Contract NBy-70026, Installation of Raised Floor, Dropped Ceiling, and Sprinkler System in Bldg 321, was awarded to Johnson-Scurlock on 22Sep for the contract amount of $9,612. This work was required to provide space for the SNMMMS Automatic Data Processing Facility. The contract was to have been completed by 8Nov; however, the contractor completed the work on 4Nov.

(14) On 22Sep65, a contract was awarded for construction of a new floor and ceiling, and installation of a sprinkler

system in Bldg #321, DPI; $9,612.70. Construction was completed on 3Nov65. Ref: NBy-57679.

(15) Telephone Exchange modification (Bldg #1) was completed on 5 October.

(16) On 8Oct65, MCAS El Toro's FY 67-71 MCON Program was submitted to BUWEPS. Program included 42 line items totaling over 30 million dollars. Ref: CG MCAS El Toro ltr 38:EJB:reh 11000/12 of 8Oct65.

(17) Western Electric Company commenced installation of CENTREX equipment on 11 October.

(18) Contract NBy-70027 was awarded to the United Corporation on 14 October for $6,190. The contract provided for cleaning, repairing and painting the Radome for the Medium Range Radar at Pleasants Peak. Work was completed on 10Nov65.

(19) On 20 October it appeared that, due to the large number of vacancies in the Lowana Housing Project, 25 of the sub-standard units could be inactivated. A request was forwarded to BuDocks, via Southwest Docks, COMELEVEN, and CMC. On 4 December, the Commandant of the Marine Corps recommended the inactivation. However, no further action has been taken by BuDocks. It is proposed to reactivate these units on 1Jul66, provided they are required.

(20) On 2 November Commissary Officer funded and Public Works personnel constructed a 3,200 sq. ft. addition to the Commissary, Bldg #30. Work was completed this date.

(21) On 3 November Contract NBy-70031, Relining 4 Jet Fuel Tanks, was awarded to the J. F. JUST Company in the amount of $7,975.00. This work was required to provide a high speed fuel facility adjacent to the parking area in order that MAC transport aircraft could be refueled expeditiously and within the time allotted for refueling. This work was to have been completed by 10 November, however, the contractor was unable to obtain the coating material from the Thikol Corporation until early December. Considerable difficulty was encountered in the sandblasting cleaning of the tanks due to the extremely wet weather. Three tanks are presently completed, and it is expected that the fourth will be completed on 5Jan66. The use of these tanks has eliminated the need for 5 refueler tankers, which will be excessed.

(22) On 6 November 1965 a new Exchange complex was opened at the Marine Corps Air Facility, Santa Ana, California.

This project, started from the ground up, includes all new buildings and parking areas and is operated as a branch of the Main Exchange at MCAS El Toro, California. The enlarged activity supplies assigned personnel and their dependents with approximately the same services that is available at MCAS El Toro.

(23) On 16 November 1965, alterations were completed in Bldg. #324, for housing the RF-4B A/C maintenance training devices; $1000,161.00. Ref: NBy-60172 and MCON EP-140.

(24) On 17 November 1965, a contract was awarded for construction of Guided Missile Magazine; $29,000.00. Ref: NBy-69784 and MCON EP-123.

(25) On 18 November 1965 construction was completed on two "E", "F" Module A/C Maintenance Hangars in Area II; $1,046,245.00. Ref: NBy-53532 and MCON EP-25.

(26) On 24 November 1965, a contract was awarded for improvements to the water distribution system throughout Area II, Wherry and Namar Housing; $236,274.00. Ref: NBy-67350 and MCON EP-24.

(27) Modification of MCAS, El Toro Communication Center in Building #59 to accomodate AUTODIN equipment commenced on 27 December. (Special Project Request El-65)

(28) On 28 December 1965 a contract was awarded for construction of a playground between Wherry and Namar housing; $16,284,00. Ref: NBy-70039.

(29) On 31 December 1965 construction of two A/C Power Check and Sound Suppression Facilities 100% completed; $212,505.00. Final acceptance pending performance test in accordance with specification. These are the first of this type facility to be installed at any Marine or Naval Air Station. Ref: NBy-57679 and MCON EP-99.

(30) During December the Air Freight and Passenger Service Section moved from two condemned Quonset Huts in the Operations area to buildings #288 and #289. This move was mandatory due to lack of cargo storage space, complete lack of passenger waiting space, and the large increase in the tempo of operations as a result of our Vietnam commitments. This move resulted in the following benefits:

(a) Shorter distance between Air Freight and Supply.

(b) Air Freight and Passenger Section in close proximity of Main Gate, Marine Exchange and Transient barracks.

(c) More adequate passenger waiting space.

(d) Adequate storage space for cargo during inclement weather.

(e) VIP waiting room.

(31) The Visiting Aircraft Line moved into building #289. This has shortened the supply line of fuel vehicles, spare parts, and greatly increased the amount of support equipment available from SO&ES.

(32) Flight Clearance was moved to building #288, thus enabling visiting pilots to file from the area where parked.

(33) During the period covered by this report the station Explosive Ordnance Disposal Team was called out as follows:

	Jul	Aug	Sep	Oct	Nov	Dec
ON STATION	5	10	5	4	6	4
OFF STATION	7	11	8	139	2	1
STANDBY FOR OVERFLIGHTS	10	4	4	3	8	12

Of interest were 139 calls received during a 4 day period in October concerning Vietnamese baby dolls, reported as possibly booby-trapped. Approximately 500 dolls were checked with negative results.

i. New Programs and Change and/or Status of Existing Programs

(1) With the increase in tempo of operations in the Far East, MCAS El Toro has become a port of debarkation of MAC aircraft carrying Marine passengers. Monthly between 25 and 30 C-135 aircraft arrive at MCAS El Toro from McGuire AFB, unload space available personnel, service the aircraft, and depart with approximately 76 Marines for Kadena AFB and Danang. They return to Kadena for pick-up of Marines returning CONUS. The C-135's either fly direct to MCAS El Toro from Kadena or via Yokota AFB in Japan. The aircraft is then turned around for another WESTPAC flight or returns to McGuire AFB.

(2) Tentative plans have been made for the modernization of the Radar Air Traffic Control Center by moving the site of the IFR room and up-dating the equipment to include the installation of the AN/FPN-47 radar. The proposed delivery date is June 1966 and will be installed on the second deck of the Operations building. The FPN-47 will replace the

FPN-37 (Medium Range Search Radar) and the precision portion of the FPN-28 radar.

(3) MAC requirements have tripled the number of trans-oceanic briefings given by Aerology. The flight distances which weather briefings cover have more than doubled. The work load imposed was instrumental in obtaining the ON-LINE DISPLAY System and the COLLECT and TRANSMIT System controlled and supported by the Fleet Numerical Weather Facility in Monterey, California. These two systems save many man hours of work daily in preparing horizontal sections.

(4) The 1401 Basic Computer System has been converted to a 1401 Disk System. This system provides random access, 12,000 positions of storage (vice 4,000 positions provided by basic system), and reduces card storage, file space, processing and operator time.

(5) Installation of 1050 Data Communication System to support SNMMMS. This system, providing electrical transmission of requisitions and related data, consists of two separate networks at this Station. One network consists of a master terminal, in the Supply Department, controlling terminals at MWSG-37, MAG-15, MAG-33, and SOES/VMT-2, and has recently been expanded to include terminals at MCAF, Santa Ana, and Camp Pendleton. The other network consists of a master terminal in the vicinity of the Stock Control Branch, Supply Department, and controls three one-way terminals located in Supply warehouses.

(6) Implementation of the Standard Navy Maintenance and Material Management System, as directed by CNO, "to improve aircraft readiness by reducing administrative downtime, and to collect and evaluate data to determine reliability, maintainability, and personnel and material resource requirements of its weapon system." Implementation of this system necessitated a 3-shift operation in this Department as well as an increased requirement for personnel and equipment.

(7) CMC ltr AO1E-nt of 28 October 1965 directed this command to place civilian incumbents in six (6) officer and eighty-four (84) enlisted military billets authorized for this command during the remainder of fiscal year 1966. This action is in keeping with the Department of Defense Civilian Substitution program.

(8) On 1 July 1965, the Data Processing Department included the audiometric testing program in its program systems.

(9) Supply Department packing and shipping operations were accelerated to support the deployment of Fleet Marine Aircraft Units to the Southeast Asia area and to handle the increased movement of supplies and stores material to overseas points. From 1 July to 31 December tonnage of overseas shipments increased 20% over the previous six months. During the same time tonnage of receipts into the department increased 13%; applications for movement of household goods increased 21%; and passenger transportation requests increased 38%. However, as a further result of squadron deployments, there was a 23% decrease in the number of locally-based aircraft supported; a 28% decrease in individual issues from stock; and 31% decrease in the quantity of jet fuel issued.

(10) The Traffic Division has been receiving, consolidating, packing and shipping materials donated by civilian companies and individuals under the Civic Action Program which commenced on 5 Aug and related Vietnam Aid programs. During the reporting period 164,000 lbs. of this material was processed and shipped, of this 3 boxcars consisting of 183 pallets weighing 126,258 lbs. was shipped as a part of the YES/ACTT Program. As of 31 December approximately 14,000 lbs. additional were on hand awaiting shipment.

(11) Supply support programs that were implemented during the period include:

(a) MILSTRAP Procedures

(b) FMSO's variable stock level (VSL) system

(c) Standard Navy Maintenance and Material Management System (3M) and installation of IBM 1050 equipment for transmission of requisitions from fleet activity to Supply Department office to warehouse.

(d) Establishment of modified second shift operations to handle 3M program.

(e) Transaction reporting of all Aviation Supply Office controlled material.

(f) Establishment of a blanket purchase agreement for Vertol spare parts as a step toward reducing the AOCP rate.

(g) Participation in outfitting of NSD, Subic Bay under projects MF4 and ZA6.

(12) Although a special effort was made to hold the AOCP rate to a low figure, the average was higher for this period than for the previous six months. The third MAW and station average AOCP rate for 1 January to 30 June was 5.6% while the average for 1 July to 31 December was 8.1%. The increase is attributed to several factors: the drain on our stocks to meet requirements for aircraft parts in Southeast Asis, acceleration of flight time by locally based squadrons, and an increase in the number of new aircraft, such as the CH46A, before adquate stocks of spares were positioned for their support.

(13) Overall gross availability of stock increased to approximately 74% as compared with 69% during the previous six months. Net availability for both periods was approximately 89%.

(14) A project began early in the year to consolidate supply bin stock into metal rotary bins was about 97% complete by 31 December. The consolidation conserves storage space, reduces walking distances for warehouse personnel, shortens fork-lift hauls, makes faster issues possible and generally streamlines the storage operations. The overall effect has been to create time for storage maintenance functions that had been neglected because of limited personnel available and to provide warehouse storage for items that otherwise would have to be stored outside.

(15) The Marine Corps Property Branch has found it advantageous to utilize the Self-Service Center at Camp Pendleton. At present approximately 75 line items are being obtained from the Center. Normally, pick-up of items is made weekly. Emergency pick-ups, however, can be made daily. Advantages to use of the Center include: a significant reduction in procurement lead time, a reduction in number of items that must be stocked, and a reduction in stock levels that must be maintained.

(16) The movement of troops in and out of El Toro increased the station's clothing support function by about 40% over the preceding six months. The increase occurred both in issues of mount-out stocks and individual issues. To improve the efficiency of the clothing store and to handle the increased business, several improvements were made to the physical layout of the store. Old, bulky wooden shelving was replaced with smaller, lighter, and more modern metal shelfing, making the storeroom more spacious and making storage and issue operations easier. Turnstiles were added at the entrance and exit of the store, making it possible to maintain an accurate count of customers and to maintain better control of the traffic in and out of the store.

(17) In the Issue Commissary area, the administrative office for subsistence was moved from a separate location to spaces adjacent to the warehouse and the receiving dock. This move significantly increased the internal administrative efficiency of the operation and made supervision and control more effective.

(18) To improve messing facilities, one of the station's older mess halls was rehabilitated, re-equipped, redecorated and placed in operation. Squadron deployments and mess personnel transfers, however, forced its closing after only a short period of operation. During the reporting period mess personnel was 35% below the previous six months even though the number of rations served was down only 12%. Consequently reconsolidation of messing facilities was necessary.

(19) The El Toro Commissary Store continues to maintain a high level of sales and normally has about 30,000 patrons a month. Approximately 3,000 stock items are carried and sales averaged $587,000 a month, reaching a high of $667,000 in December. Recent improvements in Commissary Store facilities have increased the efficiency of the operation and made it possible to serve more customers in less time. The sales area was increased by about 3800 square feet. Two additional check stands were added, frozen-food display facilities enlarged, and storage space modified.

(20) Deployments have also effected the laundry operation. The average amount of non-reimbursable laundry was down 33% from the average of the preceding six months and reimbursable laundry was down 14%.

(21) On 1 July the financial inventory control function was transferred from the Supply Department to the Comptroller Department in accordance with SecNav Inst. 7323.7. At the same time the financial records of excess and surplus material was removed from the standard financial inventory control and stores account records and in compliance with BUSANDA Inst. 4570.16, placed under a separate Property Disposal Account with ledgers maintained by the Supply Department's Disposal Division.

Approximately 65% of Supply operations are under engineered performance standards. Average effectiveness during the period of all work standards was 104%.

(22) On 14 July Air FMFPAC was disestablished. Responsibility for logistical support of Transpac Squadrons was assumed by Marine Corps Air Station, El Toro. Reference Administrative Officer FMFPAC Message 142032Z July.

(23) On 1 September Airlift of COMPHIBTRAPAC personnel established to be conducted at designated periods until December. Reference Admin CINCPACFLT Class Message 032117Z September.

(24) On 1 September SAAM airlift of rotating Marine personnel by MAC to commence and continue for an indefinite period. Reference CMC Classified Message P132204Z August.

(25) On 18Oct65 notification was received that the OSD had deleted this station's FY66 Family Housing Program. This deletion resulted in the loss of the following construction:

(a) 1 Flag Officer's Quarters - 4 bedroom

(b) 2 Senior Officer Quarters - 4 bedroom

(c) 7 Field Grade Officer Quarters - 3 bedroom

(d) 18 Company Grade Officer Quarters - 4 bedroom

(e) 202 MEMQ - 3 bedroom

Reference Bureau of Yards & Docks ltr to Director Southwest Docks, 43.712:DEW:nec of 18Oct65.

j. Command Relations

(1) The recent flow of personnel and supplies through El Toro to WESTPAC has placed added emphasis on command relations as follows:

(a) The C-135 aircraft traffic flow requires close liaison with the MAC Liaison Team assigned to MCAS El Toro, MAC Command Posts at both Travis AFB and McGuire AFB.

(b) In conjunction with the normal lift of Marines westward, coordination must be made with the Personnel Division of Headquarters Marine Corps, Camp Pendleton, Marine Barracks Treasure Island, Camp Butler, Okinawa.

(c) Freight matters require coordination with FMFPAC, Supply Center Barstow, Camp Pendleton, and many defense contractors in the local area.

(2) On 8 October, Air Bases Order 5400.1 (Command Relationships and Area Coordinations) was published. This order was precipitated by possible civil disturbances from rioting in the Los Angeles area. The order reiterates the Marine Corps responsibilities in domestic emergencies and

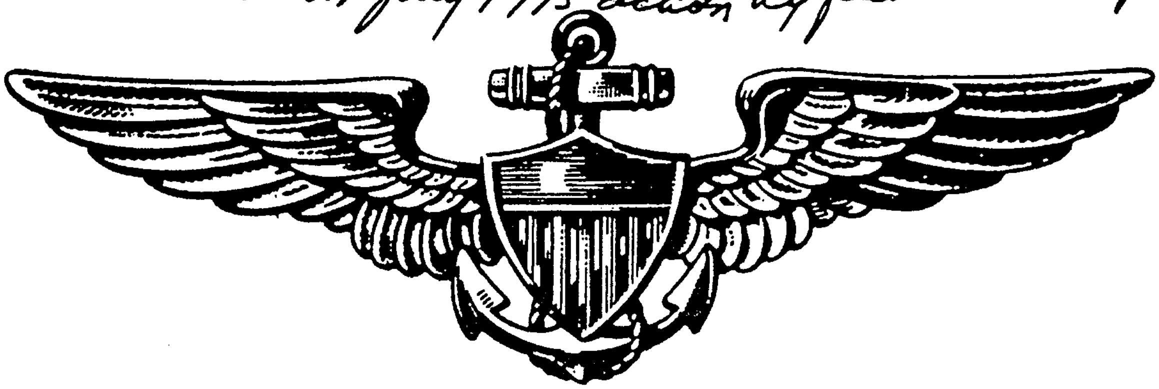
re-affirms the Command's relationship to the Naval District during such emergencies.

DECLASSIFIED

OPNAV

MONTHLY STATUS OF NAVAL AIRCRAFT

DECLASSIFIED by authority of Op 51 on 24 July 1975 action by [illegible] Op 511



AVIATION STATISTICS SECTION

FILE COPY

31 JANUARY 1947

NAVY DEPARTMENT
OFFICE OF THE CHIEF OF
NAVAL OPERATIONS

[redacted]

11651

In reply refer to Initials
and No.
Op-56C-4/DMK
Serial: 690P560

NAVY DEPARTMENT
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

7 April 1947

From: The Chief of Naval Operations.
To: The Distribution List.

Subject: The Monthly Status of Naval Aircraft.

Reference: (a) SecNav letter dated 20 April, 1945 Subject: Navy List of Aircraft. Navy Service List of Airplanes.
(b) Aviation Circular Letter 175-46 dated 10 December 1946.

Enclosure: (A) Copy of subject report.
(B) Copy of reference (a).

1. Presented herewith is a copy of the Monthly Status of Naval Aircraft as of 31 January 1947, prepared in accordance with reference (a).

2. Information contained in this publication was compiled from reports dated 31 January 1947 and submitted by the lowest echelon units of the Fleet, Training Command and other activities concerned with Naval Aircraft in accordence with reference (b).

J. I. Taylor Jr.

J. I. TAYLOR, JR.,
By direction.

11651

NAVY DEPARTMENT
Washingtion, D. C.

20 April 1945

From: The Secretary of the Navy.
To: The Chief of Naval Operations.

Subject: Navy List of Aircraft.
Navy Service List of Airplanes.

1. The following polocies and procedures are established with respect to subject lists.

2. The term "Aircraft" as used herein means heavier-than-air fixed wing aircraft, rotary wing aircraft, lighter-than-air airships, gliders and drones. The term "Airplanes" as used herein means heavier-than-air fixed wing aircraft but shall not include gliders and drones.

NAVY LIST OF AIRCRAFT

3. There shall be maintained by the Chief of Naval Operations (DCNO)(Air) a current list to be known as the NAVY LIST OF AIRCRAFT on which shall be recorded all aircraft which have been accepted by the Navy (for Navy, Marine Corps or Coast Guard use) and which have not been stricken therefrom by the Secretary of the Navy.

NAVY SERVICE LIST OF AIRPLANES

4. All airplanes exclusive of the categories listed below shall be recorded under a sub-title in the Navy List of Aircraft and as so titled shall comprise and be known as the NAVY SERVICE LIST OF AIRPLANES.

a. Airplanes accepted but not delivered.

b. Airplanes of a model (or model dash designation) declared obsolete by the Secretary of the Navy.

c. Airplanes which, having been recommended to CNO for Striking, have been expended or disposed of in the manner specified in paragraph 8 below.

5. The total number of airplanes on the Navy Service list of Airplanes shall be identified as the NAVY SERVICE LIST AIRPLANE TOTAL in all NAVY correspondence, reports, and publications.

ENCLOSURE (B)

Subj: Navy List of Aircraft.
Navy Service List of Airplanes.

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6. The Navy Service List of Airplane Total shall be employed to reflect availability of airplanes on hand for all purposes including comparison with airplane limitations.

STRIKING OF NAVAL AIRCRAFT

7. Aircraft reporting units will recommend to CNO (DCNO)(AIR) Aircraft for striking in accordance with current instructions and modifications thereto issued by CNO consistent herewith.

8. CNO (DCNO)(AIR) will recommend to the Secretary of the Navy aircraft for striking from the Navy List of Aircraft when they have been determined to the satisfaction of CNO (DCNO)(AIR) as having been:

a. lost or missing, or

b. damaged beyond economical repair, or

c. salvaged for essential equipment or parts, or

d. disposed of outside the United States pursuant to the policies of the Integrated Aeronautic Program, or

e. disposed of outside the United States as directed by CNO with SecNav approval, or

f. transferred from Naval custody.

FLIGHT OF AIRCRAFT IN OBSOLETE OR STRICKEN STATUS

9. No obsolete aircraft and no aircraft as to which a recommendation for striking has been submitted to CNO (DCNO)(AIR) shall be flown, except that flights of such aircraft are authorized for purposes of disposition either by transfer from Naval custody or by salvage or scrapping operations.

/s ARTEMUS L GATES
Acting Secretary of the Navy.

FORWARD

The information set forth in the Monthly Status of Naval Aircraft is based entirely on information submitted by the lowest echelons of command on the Monthly Reports of Aircraft in accordance with Aviation Circular Letter 175-46. The accuracy of this document depends entirely on the accuracy of the original reports submitted to CNO.

As this publication was prepared from the first reports submitted in accordance with Aviation Circular Letter 175-46 it is apparent that there is some margin of error. This is most apparent in the number of operating aircraft reported within each major command. It will be noted that in each case the operating aircraft reported exceed the authorized operating allowance of the commands.

At the present time the usefullness of this document is restricted due to the age of the information contained herein. With the speed up in reporting as set forth in ACL 175-46, it is CNO's desire to greatly speed up preparation and distribution of this document. It is further desired to increase its usefullness by the addition of further information concerning the aircraft program.

This publication is divided into three major headings:

(1) Assignment of Naval Aircraft: Sets forth the inventory, as reported, of each controlling custodian as of the date of the publication. This information is further listed by inventory within the controlling custodian where appropriate; that is, between Naval and Marine activities within the Fleet Commands and the Air Bases, and the various sub training commands within the Training Command. It will be noted that in various instances the totals of aircraft within these sub commands does not equal the over all inventory of the major command. This difference is accounted for by the aircraft which were in a transit status (enroute between activities) on the date of the publication and the assignment within the major command was not known.

(2) Status of Naval Aircraft: Sets forth the quantity of aircraft within each status by commands. These various status designations are set forth in Aviation Circular Letter 175-46 with the exception of the following:

(a) In Delivery: New Aircraft in delivery from the namufacture to the designated Naval receiving activity.

(b) Enroute Between Activities: Aircraft which were transferred during the month but not reported as received by an activity during the month. These aircraft are, in most cases, in a ferry or transit status on the last day of the month and accordingly are not reported.

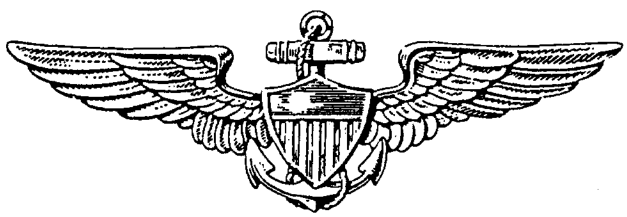
(c) Unreported: These aircraft were not reported to CNO by any activity during the month. Each of these aircraft is made the subject of a special letter of inquiry to the last known custodian and is continued as an unreported aircraft on the records of CNO until located and again reported.

(3) Location of Naval Aircraft: Sets forth the geographic location of all Naval Aircraft by quantity within each activity.

RESTRICTED

OPNAV

LOCATION OF NAVAL AIRCRAFT



1 February 1949

NAVY DEPARTMENT
OFFICE OF THE CHIEF OF
NAVAL OPERATIONS

RESTRICTED

B-123:

In reply refer to Initials and No.
Op-50308/ec
VV/A4-1
Serial: 691P50

NAVY DEPARTMENT
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON 25, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

11 March 1949

From: Chief of Naval Operations.
To: Distribution List.

Subject: Location of Naval Aircraft.

1. Presented herewith is the LOCATION OF NAVAL AIRCRAFT report as of 1 February 1949.

2. This report, to be issued each month, supersedes the monthly publication "Location of Navy, Marine, and Coast Guard Aircraft" previously prepared by DCNO (Operations) and the monthly publication "Location of Naval Aircraft" previously prepared by DCNO (Air). Distribution lists of the superseded reports have been combined to form the distribution list of this report.

3. Authorized operating allowances shown in this report were taken from the "Aircraft Complements and Allowances of the Navy and Marine Corps" effective for 1 February 1949. Aircraft inventory information in this report was taken from data submitted to this office on NavAer 2469 by reporting custodians of Navy aircraft. Locations of units at 1 March 1949 shown in footnotes to the listings herein were taken from the records of the Movement Reports Center of DCNO (Operations).

4. It is contemplated that each succeeding issue will be improved in format, content, and currency such that the maximum work-use may be realized by the distribution list. To that end, your critical comments are requested.

H T Dietrich

H. T. DIETRICH
By direction

TABLE OF CONTENTS

GENERAL

This report includes all aircraft accepted to but not stricken from the Navy List of Aircraft, including all fixed-wing and rotary-wing aircraft, lighter-than-air airships, and target drones (man-carrying), but excluding all aerial target pilotless aircraft (non-man-carrying) and guided missiles.

The total Navy aircraft inventory is presented herein in two arrangements: Section I, in alphabetic order of geographic location, showing for each location the "reporting custodians" or "unit" based there, the total aircraft in custody of each, a code designation of their respective "Controlling custodians", and the page number of Section II where more detailed information may be found; and Section II, by type of reporting custodian within each major command, showing for each unit and model of aircraft, location, authorized operating allowance, and actual inventory in number of aircraft and status thereof.

The terms "reporting custodian" and "controlling custodian" are defined in ACL 175-46 dated 10 December 1946. A "reporting custodian" is a squadron, air station, or other activity in the lowest echelon of command that is assigned or receives the physical custody of aircraft and therefore is responsible for reporting such aircraft to CNO. A "controlling custodian" is so designated by CNO as the major command that directs the employment of aircraft in custody of reporting custodians and/or is responsible for the logistic support of such aircraft, as set forth in the current issue of "Aircraft Complements and Allowances of the U. S. Navy and Marine Corps".

Code designations of major commands appearing in Section I are explained on page 3 of this report.

"Status" codes and "Authorized Use" designations appearing in Section II are explained on page 9 of this report.

In cases where the location of reporting custodians changed after the date of this report, those units are marked and footnoted to show their respective locations at the date of the transmittal letter included herein, which is the date this report went to press.

\# \# \# \#

Authorized operating allowances shown in this report are those in effect at the date of this report. Any changes thereto since that date are not reflected herein. This publication is not at this time to be used as the official CNO authorization for operating aircraft allowances which are set forth in the CNO publication "Aircraft Complements and Allowances of the Navy and Marine Corps (including the Air Reserve)" and as modified by CNO letters between publications.

\# \# \# \#

Requests for further information and comments on presentation and content of this report should be addressed to the preparing unit ---

AIRCRAFT STATISTICS SECTION
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON 25, D. C.

ABBREVIATIONS USED IN THIS REPORT
(Excluding "Status" and "Authorized Use" Codes)

ABD - Aboard (name of ship follows)
A&T - Acceptance and Transfer
ADM - Administrative
AERO LAB - Aeronautical Laboratory
AEW - Air Early Warning
AFMF - Air Fleet Marine Force
AOG - Aircraft Grounded in Transit
ASW - Anti-submarine Warfare
ATT - Naval Attache
ATU - Advanced Training Unit
AV, AVP - Seaplane Tenders

BAGR - Bureau of Aeronautics General Representative
BAMR - Bureau of Aeronautics Maintenance Representative
BAR - Bureau of Aeronautics Representative
BARR - Bureau of Aeronautics Resident Representative
BTU - Basic Training Unit
BUAER - Bureau of Aeronautics Materiel and Services Group

CAA - Civil Aeronautics Authority
CQTU - Carrier Qualification Training Unit
CV - Attack Carrier
CVB - Battle Carrier
CVE - Escort Carrier
CVG - Carrier Air Group
CVL - Light Carrier

DET - Detachment

FAETU - Fleet Airborne Electronics Training Unit
FASRON - Fleet Air Service Squadron
FAW - Fleet Air Wing
FAWTU - Fleet All-weather Training Unit
FLSW - Fleet Logistic Support Wings
FMF - Fleet Marine Force

HEDRON - Marine Headquarters Squadron
HMX - Marine Helicopter Operational Development
HTA - Heavier-than-air
HU - Helicopter Utility Squadron

IATU - Instructors Advanced Training Unit
IBTU - Instructors Basic Training Unit
IN DEL - Aircraft Accepted but Undelivered

LANT - Air Force, Atlantic Fleet
LTA - Lighter-than-air

MAS - Materiel and Services Group, BuAer
MACG - Marine Air Control Group
MAG - Marine Air Group
MATS - Military Air Transport Service
MAW - Marine Air Wing
MCAS - Marine Corps Air Station
MISS - Naval Mission

NAAS - Naval Auxiliary Air Station
NAATC - Naval Air Advanced Training Command
NAAWTS - Naval Air All-weather Training School
NABS - Naval Air Bases (Continental)
NABTC - Naval Air Basic Training Command
NADS - Naval Air Development Station
NAES - Naval Air Experimental Station
NAF - Naval Air Facility
NAIFS - Naval Air Instrument Flight School
NAMT - Naval Air Mobile Trainers
NAMTC - Naval Air Missile Test Center
NAOTS - Naval Aviation Ordnance Test Station
NART - Naval Air Reserve Training
NARTU - Naval Air Reserve Training Unit
NAS - Naval Air Station
NATAE - Naval Airship Training and Experimental
NATC - Naval Air Training Command
NATTC - Naval Air Technical Training Command
NATTU - Naval Air Technical Training Unit
NOTS - Naval Ordnance Test Station
NPG - Navy Proving Ground

O&R - Overhaul and Repair, BuAer UAS
OPDEVFOR - Operational Development Force

PAC - Air Force, Pacific Fleet
PARA EXP - Parachute Experimental Unit
PL - Pool

RD&DE - Research and Development and Design and Engineering
ROTC - Reserve Officers Training Corps

SDC - Special Devices Center

TACRON - Tactical Control Squadron

USMC - United States Marine Corps
USN - United States Navy
USNR - United States Naval Reserve

VA - Attack Squadron
VC - Composite Squadron
VF - Fighter Squadron
VMF - Marine Fighter Squadron
VMFN - Marine All-weather Fighter Squadron
VMO - Marine Observation Squadron
VMP - Marine Photographic Squadron
VMR - Marine Transport Squadron
VMT - Marine Instrument Training Squadron
VO - Observation Squadron
VP - Patrol Squadron
VR - Transport Squadron
VU - Utility Squadron
VX - Operational Development Squadron

ZP - Lighter-than-air Patrol Squadron

SECTION I

Listing of Units

Arranged alphabetically by geographic location

\# # # #

Locations are arranged in alphabetic order, except that carriers and other ships are listed first and all together, with all other locations following.

\# # # #

The total inventory of Navy aircraft, excluding aerial target pilotless aircraft (non-man-carrying) and guided misseles, is included in this Section.

The column headed "Controlling Custodian" contains their code designations, which are translated as follows:

11 ... LANT .... Atlantic Fleet (Navy)
19 ... LANT .... Atlantic Fleet (Marine Corps)

21 ... PAC .... Pacific Fleet (Navy)
29 ... PAC .... Pacific Fleet (Marine Corps)

31 ... NABS .... Naval Air Bases (Navy)
39 ... NABS .... Naval Air Bases (Marine)

35 ... USNR Based .... USNR based aircraft for USN flight proficiency.

37 ... NATAE .... Naval Airship Training & Experimental Command.

42 ... NATC .... Naval Air Basic Training Command.
43 ... NATC .... Naval Air Advanced Training Command.
44 ... NATC .... Naval Air Technical Training Command.

50 ... NART .... Naval Air Reserve Training Command.

60 ... FLSW .... Fleet Logistic Support Wings.
66 ... MATS .... Military Air Transport Service.

70 ... RD&DE .... Research & Development and Design & Engineering Groups of the Bureau of Aeronautics.

88 ... BuAer .... Materiel & Services Group, Bureau of Aeronautics.

The above classifications are for logistic purposes and statistical convenience and in no way alter any organizational structure or military command established elsewhere by the Navy.

\# # # #

The column headed "Page Number" contains references to numbers of Section II pages where more detailed information may be found concerning each reporting custodian.

\# # # #

In cases where reporting custodians have changed location after the date of the report, those units are footnoted and the locations as of the date of the transmittal letter of this report are indicated at the bottom of Section I pages.

OPNAV

ALLOWANCES and LOCATION of NAVY AIRCRAFT

OPNAV NOTICE P03110

31 DECEMBER 1964

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS

UNCLASSIFIED ON 31 DECEMBER 1962

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D. C. 20350

OPNAV P03110
OP-502D
Ser 02507P50

CONFIDENTIAL

5 FEB 1965

OPNAV NOTICE P03110

From: Chief of Naval Operations
To: Distribution List

Subj: Allowance and Location of Naval Aircraft (U)

1. Purpose.

a. To indicate the following by units (Table 1).

(1) The operating aircraft allowance.
(2) The actual on hand aircraft inventories as of 31 December 1964.
(3) The planned assignments of operating aircraft.

b. To show the actual on hand program and non-program aircraft inventory in various forms (Section II), as of 31 December 1964.

2. General Instruction.

a. This Notice establishes unit operating allowance of the Naval Aircraft Program within each major operating command. The allocation of Navy Aircraft by model is reflected in OPNAV INSTRUCTION 03110.1, "U. S. Navy Aircraft Program" (Gray Book), which establishes the allocations for major operating commands in accordance with the approved planning factors and available inventory. In those instances where apparent inconsistencies occur between operating allowances and allocations, the U. S. Naval Aircraft Program shall be the controlling instruction, since it represents the planned implementation of the aircraft program for which Congress approved and provided funds. Actual on hand aircraft inventories are developed by the Navy Aircraft Accounting System, OPNAV INSTRUCTION P5442.2A. The Naval Air Reserve Training Command, as shown herein, has been established as a major command for aircraft logistics purposes only.

b. If the allowances as set forth are not deemed suitable for the mission which an activity or command has to support, the Chief of Naval Operations will consider recommendations for changes in models and allowances of aircraft. However, any requests for such changes that would result in an increase in a major command's total aircraft operating allowance should contain that command's recommendation for a compensatory reduction.

c. Major operating commands are authorized to shift operating assignments (Table 1) from one unit to another on a temporary basis; however, if it is expected that this shift will exceed three months, the Chief of Naval Operations shall be requested to change the authorized operating allowance (Table 1).

d. Specific assignment of aircraft to individual officers is prohibited by the Secretary of the Navy. Aircraft for shore based activities not listed in Table 1 are provided within the allowance of Naval Air Bases, the Naval Air Reserve Training Command, the Naval Air Training Command, and the Bureau of Naval Weapons (Research, Development, Test and Evaluation).

e. Designations of aircraft listed herein are in conformance with BUWEPS INSTRUCTION 13100.7 of 18 September 1962.

f. Planned operating levels of target drones (capable of carrying a pilot) are contained in OPNAV INSTRUCTION 03110.1 (U. S. Naval Aircraft Program)

3. Classification. The security classification of this publication is automatically downgraded from Confidential to Unclassified on 31 December 1969. This action is in accordance with Section 3, Change 4 of OPNAV INSTRUCTION 5510.1B. Upon downgrading, this publication will be marked, "FOR OFFICIAL USE ONLY".

4. Cancellation. This Notice is cancelled and may be destroyed by burning when the next issue is received. No report of destruction is necessary. For record purposes cancel 30 April 1965.

E. J. WINTER
By direction

DISTRIBUTION
Part 1 SNDL:
21 (1) (CINCPAC only)
(3) (CINCEUR only)
(4) (CINCLANT only)
22 (2) (COMFIRSTFLT, COMSIXTHFLT only)
(3) (COMSECONDFLT, COMSEVENTHFLT only)
23A (1) (COMNAVJAPAN, COMNAVICELAND, COMNAVPHIL only)
(2) (COMNAVMARIANAS only)
23B (1) (COMASWFORPAC only)
(2) (COMMIDEASTFOR only)
24A (10) (COMNAVAIRLANT only)
(15) (COMNAVAIRPAC only)
24C (1) (COMCRUDESLANT, COMCRUDESPAC only)
24F (1) (SERVFORCOM)
24J (2) (FMFCOMDS)
26F (1) (COMNORVATEVDET only)
(2) (DEPCOMOPTEVFORPAC only)
(4) (COMOPTEVFOR only)
26K (1) (CJTG 8.3 only)
26CC (1) (FLTDET)
27C (1) (SEA FRONTIER CMDS)
27H (2) (EPDOLANT only)
28A (1) (COMCARDIVs 1, 3, 5, 7, 9, 18, 20 only)
(2) (COMCARDIVs 2, 4, 6 only)
28B (1) (ASWGRU 1, 3 only)
42A (1) (COMFAIRARGENTIA, COMFAIRCARIB, COMFAIRKEFLAVIK, COMFAIRKWEST, COMFAIRWHIDBEY only)
(2) (COMFAIRALASKA, COMFAIRMED, COMFAIRJAX, COMFAIRQUONSET, COMFAIRPAX, COMFAIRSDIEGO only)
(3) (COMFAIRHAW, COMFAIRNORFOLK, COMFAIRWESTPAC, FAIRWESTPAC DET only)
(4) (COMFAIRALAMEDA only)
42B (1) (COMFAIRWINGS 3, 4, 6, 11, 14 only)
(2) (COMFAIRWINGS 1, 2, 10 only)
(3) (COMFAIRWINGSPAC only)
(4) (COMFAIRWINGSLANT only)
42H (1) (COMUTWING)
42Q (2) (AIRFERRON 31 only)
42EE (1) (COMBARFORPAC only)
46A (2) (CGAIRFMFPAC only)
46B (1) (CG FIRSTMAW only)
(3) (CG THIRDMAW only)
(4) (CG SECOND MAW only)
46C1 (1) (MAGS 11, 12, 13, 15, 26, 33 only)
(2) (MAG 32 only)
(3) (MAGS 16, 31 only)
(6) (MAG 14 only)
50A (1) (CINCONAD only)
(2) (USCINCEUR only)
(3) (CINCSTRIKE only)
50D (2) (COMUSNAVSO only)

Part 2 SNDL:
A2A (2) (NAVCOMPT, ODA)
A3 (1) (CNO OP-05A5 only)
A4A (1) (CNM)
(105) (BUWEPS)
(1) (BUWEPS Attn: PPAC-4)
(1) (BUSANDA)
A5 (8) (BUPERS Pers-11A)
C2 (1) (NARASPO's only)
E16 (2) (NAVTRADEVCEN)
F2 (1) (ND's 6, 9, 12 only)
F14 (3) (NAVOCEANO)
F60 (1) (NAVTACDOCDEVPRODACT)
F71 (6) (NAVAVNSAFECEN)
J84 (1) (NAVPGSCHOL)
J95 (2) (NAVWARCOL)
J113 (1) (EPDOCONUS)
M9 (6) (ESO only)
M46 (2) (NAVORDSUPO)
M61 (8) (ASO only)
W1A (1) (GLYNCO, OLATHE only)
(3) (ALAMEDA only)
(4) (NORFOLK, NORIS only)
(5) (PAXRIV only)

W1A (2) (Less ALAMEDA, AGANA, ATLANTA, DALLAS, GLYNCO, GROSSE ILE, GUANTANAMO BAY, LOS ALAMITOS, MINNEAPOLIS, NORIS, OLATHE, PAXRIV, PT.MUGU, SO. WEYMOUTH, WHIDBEY IS)
W1C (1) (NAF Andrews, NAF Litchfield Pk. NAF Johnsville only)
W1E (1) (MCAS (Less Cherry Pt.))
(2) (CHERRY PT only)
W1G (1) (Less SANTA ANA)
W1H (1) (ROOSEVELT RDS, ROTA SPAIN only)

W2B (2) (COMCABS EASTERN Area only)
W3A (2) (CNATRA)
W3B (2) (CNAVANTRA)
W3C (1) (CNABATRA)
W3C (4) (CNARESTRA)
W3F (1) (CNATECHTRA)
W4A (1) (NAVAIRTECHTRACEN)
W4H (1) (NAVSCOLPREFLT)
W5P (1) (NAVWPNSYSANALO)
W6B (1) (BWR Akron, Burbank, Columbus, Long Beach, Teterboro, Englewood only)
W7C (1) (NAVAIRTESTCEN)
W7E (1) (NAVAIRDEVCEN)
W7G (1) (NAVAIRTESTFACSHIPINSTAL)
W7Q (1) (NOL CORONA only)
W7Z (1) (NAVMISCEN)
W8A (1) (MISRAN)
W9E (1) (NAVAVIONICFAC)
W11A (2) (CRANE IND.,(Code 1000) only)
W12A (1) (BWFRR (Less PAC))
(2) (BWFRR PAC only)
W12H (1) (NAVAIRTECHSERVFAC)

Director, Naval Research Lab. Wash D.C. (1)
U.S. Army War College, Attn: Library, Carlisle Barracks, Pa (1)
OASD(COMPT) Systems Analysis, Rm 3C856, Pentagon (Attn: Mr. M . Seward)
Classified Material Officer (Aviation Unit), Marine Barracks, 8th and I sts. SE. Wash D.C. (1)
Security Control Officer, Federal Aviation Agency, Systems R&D Service, RD-59, 800 Independence Ave, SW, Wash D.C. (1)
USAF Air Ground Operations School, Eglin Aux #9, Fla. (1)
Cmdt, Armed Forces Staff College, Norfolk, Va (Attn: Library)(1)
CO, Naval Aviation Eng Serv Unit, Phila, Pa (2)
Transportation Div., Plans Branch (U-4) JCS, Pentagon (1)
CO, Naval Air Eng Center, Phila, Pa. Attn: Aeronautical Structures Lab ASL (2)
OASD(Compt) Budget, Procurement Div., Rm 3D883, Pentagon (1)
Logistic Div., ANMCC, Ft. Ritchie, Md (1)
Bureau of Budget, Military Div., Navy Section, Executive Office Bldg, Wash D.C. (1)
Military Aide to the President, The White House, Wash D. C. (1)
Director, Weapons Systems Evaluation Grp., Rm 1D847, Pentagon (1)
Chief, Naval Advisory Grp, Air University Bldg, 800 Maxwell AFB, Ala (1)
Natl Military Cmd Center, Rm 2B863, Pentagon, Attn: Data Base Library (1)
Hdqtrs, U.S. Strike Cmd, OCS, MacDill AFB, Fla (1)
O&R Dept, Office Services DIO, NAS, Norfolk, Va. (3)
Wash. Regional Office, Navy Audit Munitions Bldg, Wash D. C. (1)
NAVCOSSACT (Code 02A), Bldg 210, Rm 3, Wash. Navy Yard
Director, USAF Project RAND, Via: Air Force Liaison Office, The RAND Corp, 1700 Main St., Santa Monica, Calif (Attn: Library)(1)

SecNav	(1)	OP-404W	(1)	OP-502D	(25)	OP-711	(1)		
OP-100P2	(1)	OP-405	(1)	OP-503	(2)	OP-722	(1)		
OP-03	(1)	OP-406	(2)	OP-505	(2)	OP-008	(1)		
OP-03EG2	(2)	OP-41	(1)	OP-506	(1)	OP-09	(1)		
OP-32	(1)	OP-05	(1)	OP-507	(3)	OP-09D	(1)		
OP-322D1	(1)	OP-05F	(1)	OP-52	(4)	OP-90E	(1)		
OP-33	(5)	OP-05R	(1)	OP-53	(4)	OP-92	(6)		
OP-34	(2)	OP-05W	(1)	OP-561C	(3)	OP-941Z	(1)		
OP-345	(1)	OP-50	(1)	OP-06C	(1)	OP-93D	(1)		
OP-346	(1)	OP-50C	(1)	OP-601C	(1)	OP-94G63	(1)		
OP-305F	(1)	OP-501	(31)	OP-07T	(1)	OP-944	(1)		
CNO FLAGPLOT	(1)								

TABLE OF CONTENTS

SECTION I

GENERAL

The Navy Program aircraft inventory is presented herein in three arrangements:

TABLE 1 is by type of reporting custodian within each command showing, for each unit and model of aircraft, location, authorized operating allowance, and actual inventory.

TABLE 3 is a summary of the actual operating inventory by major commands for each class, configuration and model in the program.

TABLE 4 is in alphabetic order of geographic location except that carriers and other ships are listed first showing for each location the "reporting custodians" or "unit" based there, the total aircraft in custody of each, and a code designation of their respective "command". The column headed Command contains their code designations, which are translated as follows:

11.......LANT..........................Atlantic Fleet (Navy)
19.......LANT..........................Atlantic Fleet (Marine Corps)

21.......PAC...........................Pacific Fleet (Navy)
29.......PAC...........................Pacific Fleet (Marine Corps)

31.......NABS..........................Naval Air Bases (Navy)
39.......NABS..........................Naval Air Bases (Marine Corps)

41.......NABTC.........................Naval Air Basic Training Command
43.......NAATC.........................Naval Air Advanced Training Command
44.......NATTC.........................Naval Air Technical Training Command

50.......NART..........................Naval Air Reserve Training Command

70.......RDT&E.........................Research, Development, Test & Evaluation

88.......BUWEPS........................Fleet Readiness, BUWEPS

The above classifications are for logistic purposes and statistical convenience and in no way alter any organizational structure or military command established elsewhere by the Navy.

SECTION II

NAVAL AIRCRAFT CLASSES AND SUB-CLASSES

CLASS	SUB-CLASS	TITLE	MODELS
VF	-FB	Fighter-Bomber	F-1E, F-3B, F-4A, F-4B, F-4G, F-6A, F-8A, F-8B, F-8C, F-8D, F-8E, AF-9J, F-10B, F-11A, F-111B
	-P	Photo Recon	RF-4B, RF-8A, RF-9J
VA	-H	Heavy Attack	A-3A, A-3B
	-L	Light Attack	AF-1E, A-4A, A-4B, A-4C, A-4E, A-7A
	-LP	Light Attack (Prop)	A-1E, A-1G, A-1H, A-1J
	-M	Medium Attack	A-6A
	-P	Photo Recon (Long Range)	RA-3A, RA-3B
	-Q	ECM Recon (Long Range)	EA-3A, EA-3B
	-QM	ECM Tactical	EA-6A, EF-10B
	-QMP	ECM Tactical (Prop)	EA-1F
	-R	Recon (Long Range)	A-5A, RA-5C
VS		ASW (Carrier Based)	S-2A, S-2C, S-2D, S-2E, S-2F
VP	-L	ASW Patrol (Shore Based)	P-2E, EP-2E, SP-2E, P-2F, P-2G, P-2H, SP-2H, P-3A
	-S	ASW Patrol (Sea Based)	P-5A, SP-5A, P-5B, SP-5B
VW	-M	AEW Medium (Carrier Based)	EA-1E, E-1B, E-2A
	-H	AEW Heavy (Shore Based)	EC-121K, EC-121M, EC-121P, NC-121K, WC-121N
VR	-C	Carrier Transport	C-1A, C-2A
	-M	Medium Transport	C-4B, C-47H, LC-47H, VC-47H, C-47J, VC-47J, C-117D, LC-117D, VC-117D, C-119F, C-131F, C-131G
	-H	Heavy Transport	C-54P, C-54Q, C-54R, C-54S, C-54T, NC-54R, VC-54N, VC-54P, VC-54Q, C-118B, VC-118B, C-121J, C-130F, LC-130F, C-130G
VG		Airborne Refueler	KC-130F
VU	-G	Air-Sea Rescue (Sea)	HU-16B, HU-16C, HU-16D, TU-16C
	-L	Utility, Light	O-1B, O-1C, U-1B, U-6A, U-11A
	-M Tow	Utility, Medium	UA-1E, UB-26J, US-2A, US-2C
	-MJ	Utility, Medium (Jet)	VA-3B, T-39E
	-MP	Photo Recon (Prop)	RS-2C, RC-45J
VT	-AJ	Advanced Jet Trainer	TF-8A, TF-9J
	-BJ	Basic Jet Trainer	T-1A, T-2A, T-2B, T-33B
	-SJ	Special Jet Trainer	TA-3B, TF-10B, T-39D
	-AP	Advanced Prop Trainer	TC-45J, TS-2A, U-3
	-BP	Basic Prop Trainer	T-28A, T-28B, T-28C
	-PP	Primary Prop Trainer	T-34B
	-SP	Special Prop Trainer	EC-1A, TC-4B, T-29B, EC-47H, EC-47J, SC-47H, SC-47J, TC-47H, TC-47J, TC-47K, TC-117D
H	-G	Air-Sea Rescue Helo	UH-2A, UH-2B, CH-19E
	-H	Heavy Assault Helo	CH-37C, CH-53A
	-L	Light Utility Helo	UH-1E, UH-13P, TH-13M, TH-13N, CH-43D
	-M	Medium Assault Helo	RH-3A, VH-3A, UH-19F, LH-34D, UH-34D, VH-34D, UH-34E, UH-34G, UH-34J, CH-46A, UH-46A
	-S	ASW Helo	SH-3A, SH-34J
VK	-D	Drone Control	DB-26J, DF-6A, DF-8A, DF-8F, DF-9F, DP-2E, DT-28B, DT-33B, DT-33C
		Conversion	F-9F, F-9H, F-9J
	-K	Target Drone	QF-8A, QF-9F, QF-9G
HK	-S	ASW Drone	QH-50C

STATUS CODES

Table one of this report includes a column headed "STATUS" which refers to aircraft status code classifications as defined in OPNAV INSTRUCTION NO. P5442.2A For full status code definitions, see reference.

AIRCRAFT STATUS CODES

The PROCESS Involved (PROCESS includes the following categories: Operating, Standard Rework, Special Rework, Storage, Retirement and Strike, and Miscellaneous, together with all associated subdivisions.)

OPERATING – Primary Use:	IN the Process	AWAITING the Process: (Note 1) In an Operating Command	AWAITING – IN BUWEPS: New Aircraft in Process of First Delivery (Note 2)	AWAITING – IN BUWEPS: Other Aircraft	ENROUTE TO the Process: (Note 1) By Flight	ENROUTE TO the Process: By Surface Transport
Combat	A1	B1	Use BX if com-	Use BY if com-	C1	C9
Combat Services	A2	B2	pletely RFI	pletely RFI	C2	C9
Student Pilot Training	A3	B3	If Not RFI use B	If Not RFI use B	C3	C9
Post-Student Training	A4	B4	letter to indicate	letter to indicate	C4	C9
Crew Training	A5	B5	Missing Material	Missing Material	C5	C9
Individual Proficiency	A6	B6	BA Airbourne Eq.	BN Airbourne Eq.	C6	C9
Weapon System Evaluation	A7	B7	BB Armament	BP Armament	C7	C9
Utility (Including Administrative	A8	B8	BC Electronics	BQ Electronics	C8	C9
Test Aircraft, Navy Operated	AJ	BJ	BD Photo	BR Photo	CJ	C9
Test Support Aircraft, Navy Operated	AK	BK	BE Power Plant	BS Power Plant	CK	C9

STANDARD REWORK	In a Rework Process	Rework Process Completed Awaiting Flight Check	To be reworked where now located: Flyable	To be reworked where now located: Non-Flyable	To be transferred elsewhere for rework: Flyable	To be transferred elsewhere for rework: Non-Flyable	By Flight	By Surface Transport
Overhaul	D1	DA	E1	EA	EJ	ER	F1	FA
Progressive Maintenance-Conversion	D2	DB	E2	EB	EK	ES	F2	FB
Progressive Maintenance	D3	DC	E3	EC	EL	ET	F3	FC
Overhaul-Conversion	D4	DD	E4	ED	EM	EU	F4	FD
Progressive Aircraft Rework	D5	DE	E5	EE	EN	EV	F5	FE
Airline Maintenance	D6	DF	E6	EF	EO	EW	F6	FF
Progressive Aircraft Rework-Conversion	D7	DG	E7	EG	EP	EX	F7	FG
Aircraft with Class B Damage				EH		EY		FH

SPECIAL REWORK	In the Process	To be reworked where now located: Flyable	To be reworked where now located: Non-Flyable	To be transferred elsewhere for rework: Flyable	To be transferred elsewhere for rework: Non-Flyable	By Flight	By Surface Transport
Conversion	G4	H4	HD	HM	HU	I	I9
Modification	G5	H5	HE	HN	HV	I	I9
Repair	G6	H6	HF	HC	HW	I	I9
Modernization	G7	H7	HG	HP	HX	I	I9
Modernization-Conversion	G8	H8	HH	HQ	HY	I	I9

STORAGE (Note 3) (NOTE 7)	In Containers	Not In Containers	Flyable	Non-Flyable	By Flight	By Surface Transport
Standard Rework Required:						
Undamaged Aircraft	MW	MX	NX	NW	OX	OW
Aircraft with Class B Damage		MK		NK		OK
Aircraft with Class C or D Damage	MC	ML	NC	NL	OC	OL
Standard Rework Not Required:						
Undamaged Aircraft	MZ	MY	NY	NZ	CY	OZ
Aircraft with Class C or D Damage	MD	MM	ND	NM	OD	OM

RETIREMENT AND STRIKE	Awaiting Decision to Strike: Flyable	Awaiting Decision to Strike: Non-Flyable	Awaiting Strike: Flyable	Awaiting Strike: Non-Flyable	Awaiting Strike for MAP: Rework Not Involved	Standard Rework Involved: In the Process	Standard Rework Involved: Awaiting or Enroute	Special Rework Involved: In the Process	Special Rework Involved: Awaiting or Enroute	Stricken
Category 1 . . . . Damage		Y		Y						1S
Category 2 . . . . Depreciation	P2	PB	S2	SB	R	RD	RE	RG	RH	2S
Category 3 . . . . Administrative	P3	PC	S3	SC	R	RD	RE	RG	RH	3S
Category 4 . . . . Completed Service Life	P4	PD	S4	SD	R	RD	RE	RG	RH	4S

MISCELLANEOUS

Bailment (NOTE 4)	*Test Aircraft*	TJ
	Test Support Aircraft	TK
	Contract Pending	TR
Loan (NOTE 4)	By the Navy	
	Not RDT&E	U
	Test Aircraft	UJ
	Test Support Aircraft	UK
	To the Navy	
	Not RDT&E	U5
	Test Aircraft	U6
	Test Support Aircraft	U7
Provisionally Accepted		V letter (NOTE 5)
Grounded, Structural		X
Disposition Undetermined	Awaiting	Y
	Enroute	Z
Contingency Reserve: (NOTE 6) (NOTE 7)		
Stored	In containers	WA
	Not in Containers	WB
Not Stored	Flyable	WD
	Non-Flyable	WE

NOTES:

1. A "B number" or "C number" status means that the aircraft could be changed to an operating (A number) status without undergoing Standard or Special Rework. The second character of the B number and C number code shall be selected to indicate the primary use of the aircraft when it is next assigned to Operating.
2. Use status code BA, BB, BC, BD and BE to indicate an aircraft in the "first delivery" process which has a discrepancy pending completion, modification or installation work to be performed by *BUWEPS FR*.
3. Does not include stored aircraft which have completed Standard Service Life. See Note 6.
4. CNO approval is prerequisite before change to a Bailment or Loan status.
5. Status Code "V letter" will be used to indicate that the aircraft has been accepted provisionally or under special conditions pending completion of work by the airframe contractor. Use Code VN, VP, VQ, VR, or VS to indicate the major area of discrepancy as airborne equipment, armament, electronics, photo equipment or *power plant respectively*.
6. Aircraft which have completed Service Life.
7. Status codes M letter, N letter, O letter and W letter whenever used, must include a third character (1, 2, 3 or 4) to indicate Retention Category. The Retention Categories and codes therefor are as *follows*: *RESERVE STOCK* - "1," *MOBILIZATION* RESERVE - "2," ECONOMIC RETENTION - "3," and CONTINGENCY RETENTION - "4." Definitions of the Retention Categories are located in Part VI (Glossary) of this instruction.

In addition, those aircraft being held pending future DRONE conversion will be so indicated by the letter "K" included as a fourth character in the Status Code.

See GLOSSARY (Part VI of this instruction) for explanation of all terminology used above.

LOCATION OF NAVY AIRCRAFT
ABBREVIATIONS USED IN THIS REPORT
(Excluding "Status" Codes)

ABD - Aboard (name of ship follows)
ACFT - Aircraft
ADV - Advisory or Advance
AES - Aircraft Engineering Squadron
AEWBARRON - Airborne Early Warning Barrier Squadron
AEWTRAUNIT - Airborne Early Warning Training Unit
AFB - Air Force Base
AFMF - Aircraft, Fleet Marine Force
AGRI - Agriculture, Department of
ASW - Anti-Submarine Warfare
ATT - Naval Attache
AV - Seaplane Tender

BARR - Barrier
BIS - Board of Inspection and Survey
BUWEPS - Bureau of Naval Weapons
BWFLTRREP - Bureau of Naval Weapons Fleet Readiness Representative
BWGR - Bureau of Naval Weapons General Representative
BWMR - Bureau of Naval Weapons Maintenance Representative
BWR - Bureau of Naval Weapons Representative
BWRR - Bureau of Naval Weapons Resident Representative

CEN - Central
CMEF - Commander of Middle East Forces
COM - Commander
COMNAVFOR - Commander Naval Force
COMUSTDC - Commander U. S. Taiwan Defense Command
CONAD - Continental Air Defense
CVA - Attack Carrier
CVW - Attack Carrier Air Wing
CVS - Anti-Submarine Warfare Support Aircraft Carrier
CVSG - Anti-Submarine Warfare Carrier Air Group

DET - Detachment
DST - District

ECM - Electronic Counter Measure

FAA - Federal Aviation Agency
FAC - Facility
FAHS - Fleet Aircraft Headquarters Squadron
FAWPRA - Fleet Air West Pac Repair Activity
FLT - Fleet
FMF - Fleet Marine Force
FR - Fleet Readiness, BUWEPS

H&HS - Headquarters and Headquarters Squadron
H&MS - Headquarters and Maintenance Squadron
HDQTRS, HQ - Headquarters
HMH - Marine Helicopter Transport Squadron (Heavy)
HMM - Marine Helicopter Transport Squadron (Medium)
HMX - Marine Helicopter Operational Development Squadron
HQ, HDQTRS - Headquarters
HS - Helicopter Anti-Submarine Squadron
HT - Helicopter Training Squadron
HU - Helicopter Utility Squadron

INSMAT, INM - Inspector of Naval Material
INT - Interior, Department of

JUSMAG - Joint U. S. Military Advisory Group

LANT - Naval Air Force, Atlantic Fleet
LPH - Assault Amphibious Ship

MAAG - Military Assistance Advisory Group
MAMS - Marine Aircraft Maintenance Squadron
MC - Marine Corps
MCAAS - Marine Corps Auxiliary Air Station
MCAF - Marine Corps Air Facility
MCAS - Marine Corps Air Station
MINDEFDEVU - Mine Defense Development Unit
MWSG - Marine Wing Service Group

NAAS - Naval Auxiliary Air Station
NAATC - Naval Air Advanced Training Command
NABS - Naval Air Bases
NABTC - Naval Air Basic Training Command
NADC - Naval Air Development Center
NADU - Naval Air Development Unit

NAF - Naval Air Facility
NAMC - Naval Air Material Center
NAMD - Naval Air Maintenance Department
NART - Naval Air Reserve Training
NARTU - Naval Air Reserve Training Unit
NAS - Naval Air Station
NASA - National Aeronautics and Space Administration
NASWF - Naval Air Special Weapons Facility
NATECHTRAU - Naval Air Technical Training Unit
NATRA - Naval Air Training
NATSF - Naval Air Technical Services Facility
NATTC - Naval Air Technical Training Command
NATU - Naval Air Torpedo Unit
NAV - Naval
NAVCICOFFSCOL - Naval Combat Information Center Officers' School
NAVCRUIT - Navy Recruiting
NAVSECMAGG - Navy Section Military Assistance Advisory Group
NAVSTA - Naval Station
ND - Naval District
NMF - Naval Missile Facility
NPF - Naval Parachute Facility
NTDC - Naval Training Device Center
NWEF - Naval Weapons Evaluation Facility
NWL - Naval Weapons Laboratory

OH - Overhaul
ONR - Office of Naval Research
OPTEVFOR - Operational Test and Evaluation Force
OPTL - Operational
O & R - Overhaul and Repair, BUWEPS FR

PAC - Naval Air Force, Pacific Fleet
PMRFAC - Pacific Missile Range Facility
PRNC - Potomac River Naval Command

RCVW - Replacement Attack Carrier Air Wing
RCVSG - Replacement Anti-Submarine Warfare Carrier Air Group
RDT&E - Research, Development, Test and Evaluation, BUWEPS
RFI - Ready For Issue
RNG - Range

SC&ES - Station Operations and Engineering Squadron
SQDN - Squadron
SRNC - Severn River Naval Command
SUPP - Support

TAC - Tactical
TRARON - Training Squadron

USMC - United States Marine Corps
USN - United States Navy
USNMC - United States Naval Missile Center
USNR - United States Naval Reserve

VA - Attack Squadron
VAH - Heavy Attack Squadron
VAP - Photographic Squadron
VAW - Carrier Special Squadron, Air Early Warning
VMA - Marine Attack Squadron
VMCJ - Marine Composite Photographic Squadron
VMF - Marine Fighter Squadron
VMGR - Marine In Flight Refueling Squadron
VMJ - Marine Photographic Squadron
VMO - Marine Observation Squadron
VMR - Marine Transport Squadron
VMT - Marine Corps Fleet Training Squadron
VP - Patrol Squadron
VQ - Electronic Counter Measure Squadron
VR - Transport Squadron - Fleet Tactical Support Squadron
VRC - Fleet Tactical Support Squadron, Carrier
VS - Anti-Submarine Squadron
VU - Utility Squadron
VW - Air Early Warning Squadron
VX - Air Operational Development Squadron

NOTE: For information as to abbreviations used to designate class, subclass and version of aircraft, see page 63.

MAR 31, 1980

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[redacted]

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ALLOWANCES AND LOCATION OF NAVAL AIRCRAFT (U)

DECLASSIFIED

OPNAV NOTICE C3110

31 MARCH 1980

THIS ISSUE CONTAINS ALLOWANCE INFORMATION (PROJECTED FOR END FY 1980)

DEPARTMENT OF THE NAVY

OFFICE OF THE CHIEF OF NAVAL OPERATIONS

CLASSIFIED BY OPNAVINST C5513.2A-36
DECLASSIFY ON 31 MARCH 1983

[redacted]

DECLASSIFIED

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, DC 20350

DECLASSIFIED

Canc frp: Mar 81

OPNAVNOTE C3110
Ser 508/C745001
22 May 1980

CONFIDENTIAL (Unclassified upon removal of enclosure)

OPNAV NOTICE C3110

Subj: Allowance and location of Naval aircraft

Ref: (a) OPNAVINST C3110.1B of 2 May 73, U.S. Naval Aircraft Program
(b) OPNAVINST 5442.2D of 31 Aug 73, Aircraft Inventory Reporting System
(c) OPNAVINST C5513.2A-36 of 19 Mar 79

Encl: (1) Allowance and Location of Naval Aircraft

1. Purpose. To promulgate unit operating aircraft allowances for FY 80 and actual on-hand aircraft inventories as of 31 March 1980.

2. General Instructions

a. Enclosure (1) establishes unit operating allowances of the naval aircraft program within each major operating command, projected for end FY-80. The allocation of naval aircraft by model is reflected in reference (a), which establishes the allocations for major operating commands in accordance with the approved planning factors and available inventory. In those instances where apparent inconsistencies occur between operating allowances and allocation, reference (a) shall be the controlling instruction, since it represents the planned implementation of the aircraft program for which Congress approved and provided funds. Actual on-hand aircraft inventories are developed by reference (b).

b. If the allowances set forth are not deemed suitable for the mission which an activity or command must support, the Chief of Naval Operations will consider recommendations for changes in models and allowances of aircraft. However, any requests for such changes that would result in an increase in a major command's total aircraft operating allowance should contain that command's recommendation for a compensatory reduction.

c. Specific assignment of aircraft to individual officers is prohibited by the Secretary of the Navy.

d. Designation of aircraft listed herein is in conformance with reference (a).

e. Reporting custodians shall select and report operating and awaiting operating status codes, so that the primary use feature of the status code will conform to assigned primary use codes of allowed aircraft.

3. Distribution. Each addressee is requested to review his need for this publication and inform the Chief of Naval Operations (Op-508) if subsequent editions are not desired. Requests for additional copies or addition to the distribution list must be justified on an individual basis.

4. Classification. Users of this publication should refer to reference (c) to ascertain the proper classification of extracted information.

5. Cancellation Contingency. This notice is canceled upon receipt of the superseding issue, and may be destroyed without report.

J. A. MCKENZIE
By direction

DECLASSIFIED

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Navy Deputy Director, Electromagnetic Compatibility Analysis Center, Annapolis, MD 21402 (1)
Defense Mapping Agency, Aerospace Center, (ATTN: DMAAC/ADLD), St. Louis Air Force Station, MO 63125 (1)
Naval Electronic Systems Command Technical Liaison Representative, 95 Canal Street, Nashua, New Hampshire 03060 (1)
Department of the Navy, Office of the Navy Representative, Federal Aviation Administration, Western/Northwest/Rocky Mountain and Alaskan Regions, P.O. Box 92007, Worldway Postal Center, Los Angeles, CA 90009 (1)
Defense Mapping Agency, Depot Hawaii, Hickam AFB, Hawaii 96853 (1)

OP's 09BH, 09B15C (6), 090X, 901F, 902, 906, 96D, 962Y, 944, 981E, 982E, 008, 111C, 03EG (2), 05, 05D2, 05F, 506, 508, 508D (25), 51, 51C, 511 (28), 514, 52 (4), 55, 592C, 64, and 643.

El Toro

KV40/A7-1(1)
JPA/lks
Serial ET-1310

U.S. MARINE CORPS AIR STATION
EL TORO, CALIFORNIA

April 5, 1943

[redacted]

From: The Commanding Officer
To: The Chief of the Bureau of Aeronautics.

Subject: Bi-monthly News Letter for Period March 15-31.

1. This station was formally commissioned on 17 March 1943, by the Commanding Officer, Lt. Col. T. B. Millard, USMC. The simple and dignified ceremonies were conducted before a distinguished audience which included Brig. Gen. George Walton, Chief of Staff, Army Air Forces, West Coast Training Center, Capt. Howard N. Coulter, Commanding Officer of the Naval Air Station, Santa Ana, California, who also acted as personal representative of the Commandant of the Eleventh Naval District, and Col. W. A. Robertson, Commanding Officer of the Santa Ana Army Air Base.

2. The commissioning ceremonies marked the conclusion of an arduous phase in the station's history which began with the arrival of Col. Millard on 23 September 1942. At that time what is now a flourishing air station was a bean field of several thousand acres.

3. Until the latter part of December 1942, personnel were quartered in a ranch house on the Irvine Ranch. The first barracks and mess hall were opened on 30 December 1942.

4. The Guard Detachment came aboard 21 January 1943, during one of the heaviest wind and rain storms recorded in this area in years. While the storm did considerable damage to the grounds and grading the buildings weathered the storm well.

5. The Operations Tower was opened on 23 January 1943.

6. Capt. Marion Carl, USMC, who is credited with shooting down sixteen Jap planes and holds the Navy Cross, was awarded the Gold Star Citation on 19 March 1943. At the same ceremony StfSgt Meade T. Johnson and Sgt. Warren H. Van Kirk were decorated with the Distinguishe Flying Cross. The presentations were made by Maj. General Ross E. Rowell, USMC.

7. The present station activities are functional in every respect and, although there is still considerable construction in many areas, the station as a whole is completed and a vital entity in Marine Corps Aviation. Present organizational activity is being directed towards the completion of the enlisted men's recreational center, station library, station theater and Post Exchange.

/s/ T. B. MILLARD

IN REPLYING
REFER TO NO.
KV40/A9/IWM:ajf/av
Serial: 22-14

U. S. MARINE CORPS AIR STATION
EL TORO, CALIFORNIA

5 FEB 1947

From: Commanding General.
To : Chief of Naval Operations, Aviation History Unit, OP-519B.

Subject: U. S. Marine Corps Air Station, El Toro (Santa Ana), California, History of.

References: (a) Aviation Circular Letter 22-46, dtd 8Feb46.
(b) CNO Aviation Circular Letter 71-46, dtd 30Apr46.
(c) Manual for Historical Officers, NavAer 00-25Q-26.

Enclosure: (A) History of USMCAS, El Toro for quarter 1 October - 31 December, 1946.

1. In compliance with reference (b), the History of the U. S. Marine Corps Air Station, El Toro (Santa Ana), California, is herewith submitted.

I. W. MILLER

cc: CMC; Comdt 11ND; CDR NAB; CDR MAWC

AEROLOGY

During the past three months the Aerological office has continued to function on a reduced schedule with limited personnel, normally operating from 0600 to 1800 daily, except when night flying operations require local weather observations until the field secures.

Few changes have been effected except in number of personnel, that being reduced from five (5) qualified forecasters and five (5) strikers in October, to three (3) qualified forecasters and six (6) strikers in December 1946.

AIRCRAFT ENGINEERING

During the period covered by this report, this organization has accomplished the following aircraft repair work:

Engine changes:	14 F4Us, 1 SNJ, 2TBMs, 1F7F
Bureau changes:	42 F4Us
Minor repairs:	19 F4Us, 2 TBMs, 1 SNB, 1 F7F, 3 R4Ds, 3 R5Cs, 2 JRBs, 1 OY
Steam clean and paint:	14 F4Us, 6 F7Fs, 4 SNJs
Steam clean only:	1 F4U, 3 F7Fs, 1 JM, 1 SNJ, 2 R4Ds
Minor paint work:	3 F4Us, 1 F6F, 1 F7F, 1 SnJ, 2 JRBs
Preservation:	3 F4Us, 1 F6F, 3 JMs, 1 R4D, 1 SB2C
Depreservation:	5 F4Us, 2 JMs

From 1 November 1946 to 20 November 1946, seven (7) students were given a course in basic electronics materiel and maintenance instruction. Twenty hours of lectures were given, and the students have been engaged further in "on the job" instruction with experienced technicians since the end of the classroom lectures.

On 3 October 1946, the Mobile Radio Unit and the Ground Control Approach Unit were commissioned in the Electronics Section of this organization. On 14 and 16 November 1946, these units set up mobile radio units for use by Marine Air, West Coast, in the joint Army-Navy maneuvers at Camp Joseph H. Pendleton, and installed receivers in the old tower.

On 8 October 1946, the electronics gear was removed from the R3Ds in the Salvage Yard, and, on 23 and 24 October 1946, an inventory of the Station communications equipment was conducted.

The school in basic aircraft maintenance which was inaugurated on 21 September 1946, has given over one hundred fifty (150) students a minimum of one hundred sixty (160) classroom hours of instructions in structures, accessories and instruments, engines, propellers, electricity, trouble shooting, and hydraulics. Qualified non-commissioned officers instructed by means of lectures, discussions, and movies. Students kept notes on classes and were required to spend half of each day in practical application on aircraft repair jobs with competent mechanics. Students were graded on attitude, initiative and intelligence.

U. S. MARINE CORPS AIR STATION
EL TORO (SANTA ANA) CALIFORNIA

KV40/A9:FMJ-hen
Serial 435-12

12 MAY 1947

MCAS-El Toro

From: Commanding Officer, U. S. Marine Corps Air Station, El Toro (Santa Ana), California.
To: Chief of Naval Operations, Aviation History Unit, OP-519B.

Subj: U. S. Marine Corps Air Station, El Toro (Santa Ana), California, History of.

Refs: (a) Aviation Circular Letter 22-46, dtd 8 Feb 46.
(b) CNO Aviation Circular Letter 71-46, dtd 30 Apr 46.
(c) Manual for Historical Officers, NavAer 00-25Q-26.

Encl: (A) History of USMCAS, El Toro for quarter 1 January - 31 March 1947.

1. In compliance with reference (b), the History of the U. S. Marine Corps Air Station, El Toro (Santa Ana), California, is herewith submitted.

F. M. JUNE
Acting

CC:
CMC
Comdt 11ND
Comdr NAB
Comdr MAWC

- -

AEROLOGY

For the past three (3) months the Aerological office has operated on a twenty-four (24) hour basis, beginning 6 January 1947, due to an increase in observer (SSN-885) personnel. Personnel now numbers two (2) forecasters (SSN-787), ten (10) observers (SSN-885) and five (5) strikers (SSN-521).

No other significant changes have been effected to date.

AIRCRAFT ENGINEERING

During the period covered by this report, this organization has accomplished the following aircraft repair work:

Engine Changes:	4 F4Us, 2 R4Ds
Bureau Changes:	38 F4Us
Minor Repairs:	11 F4Us, 4 R4Ds, 1 OY, 6 R5Ds, 5 JRBs, 1 R50
Major Overhaul:	1 F4U
Radio Work:	2 FTs
Steam Clean & Paint:	4 R4Ds, 4 F4Us, 4 SNJs, 1 SNB, 3 JRBs
Steam Clean:	2 F4Us, 3 F7Fs, 3 R4Ds, 19 R5Ds
Minor Paint Work:	4 F4Us, 9 R4Ds, 13 R5Ds, 2 SNJs, 4 JRBs, 1 SNB
Preservation:	4 FTs, 7 F4Us, 4 SNJs
Depreservation:	None
Salvage:	2 FT-1s, 2 F4Us

The Electronics Section carried on the following activities:

Maintained Radio gear in Station Operations Crash Equipment; maintained Receivers and Transmitters Remote Equipment in Station Control Tower; installed and maintained Receivers and Transmitters Remote Equipment in the Tactical Radio Tower at Building #6; repaired Aircraft and Ground Radio Equipment for Air Group Units until 15 March 1947, when this work was discontinued due to personnel shortages; removed five (5) units of FM radio equipment from Station Security vehicles and stored same; installed two (2) CPN-8 Radar Beacons in Building #296 and maintained same; installed two (2) YG homing transmitters in Building #296 and maintained same; maintained one (1) MBS Mobile Radio Unit and, when necessary, prepared same for emergency operation; worked on an installation of ultra-sonic training equipment at the Ground Training Building; removed and preserved all Radio and Radar equipment from two (2) FT aircraft; accomplished one (1) ARC-1 installation in R4D and one (1) Rdo. Cps. - Mkr. Beacon Receiver installation in F4U.

After graduating thirty (30) students this quarter, the basic aircraft maintenance instruction was discontinued.

Captain William L. Woodruff, former executive officer, relieved Lieutenant Colonel Norman J. Anderson as commanding officer on 2 January 1947, on which date Captain Elmer R. Wirta became executive officer, and Captain William M. Streeter became engineering officer, relieving Captain Woodruff in that capacity. On 4 February 1947, Captain Horace "D" Geer joined this organization as executive officer and engineering officer. On 6 March 1947, Lieutenant

AIRCRAFT ENGINEERING (Continued)

Colonel George W. Nevils joined as commanding officer, and Captain Woodruff resumed his former duties as executive officer.

CHAPLAIN

During the period covered by this report the following chaplins were attached to this station:

Commander Roland W. Faulk, ChC, USN
Lieutenant Commander Thomas J. Burke, ChC, USNR
Lieutenant Ernest D. Miller, ChC, USN.

Divine Services were held regularly as follows:

(a) Sundays:
Protestant at 1000
Catholic at 0830 and 1200.

(b) Daily:
Catholic at 1200

(c) Weekly Protestant Bible classes held on Thursdays at 1800.

Clerical assistance provided during this period were three (3) clerk-typists.

Reconstruction of the Station Chapel was begun, and it is expected that it will be completed by 1 May 1947. Divine Services have been held in the temporary chapel, the former Recreation Center.

COMMISSIONED OFFICERS' MESS

The New Year began with a New Year's Eve dance which was held in the new club building of the Commissioned Officers' Mess. On 10 January 1947, the quarterly reception was held in honor of Major General Louis E. Woods, Commander, Marine Air, West Coast and Brigadier General Ivan W. Miller, Commanding General, Marine Corps Air Station, El Toro. Bi-monthly Bingo parties were continued throughout the month of January. On 25 January the first of the bi-monthly Saturday night dances was held in the club building of the Commissioned Officers' Mess.

A farewell reception for Brigadier General Ivan W. Miller took place on 21 February. Bi-monthly Bingo parties were discontinued due to the lack of attendance. During the month of February the Saturday night dances were held on the 8th and 22nd of February.

The Snack Bar, located in building #38, was opened on 13 March and has proved it's popularity in the month it has been in operation. The Tacky dance on 8 March was a huge success and a regular dance took place on 22 March.

RESTRICTED
SECURITY INFORMATION

HEADQUARTERS
U. S. MARINE CORPS AIR STATION
EL TORO (SANTA ANA) CALIFORNIA

60:AGB:dem
A12
Ser 177-60

4 FEB 1953

From: Commanding Officer, MCAS, El Toro (Santa Ana), California
To: Chief of Naval Operations (Aviation History and Research Section)

Subj: U. S. Marine Corps Air Station, El Toro (Santa Ana), California; history of

Ref: (a) OpNav Instruction 575.2 of 12 Jun 1951

Encl: (1) History of USMCAS, El Toro for 1 July 1952 through 31 Dec 1952

1. In compliance with reference (a), the History of the U. S. Marine Corps Air Station, El Toro (Santa Ana), California, for the period 1 July 1952 through 31 December 1952, is submitted herewith.

D. F. O'NEILL

Copy to:
Commandant of the Marine Corps
Via: (1) Commander, Naval Air Bases, 11 & 12 Naval Districts
(2) Commandant, 11th Naval District
Commandant, Marine Corps Schools (3)

RESTRICTED

APPENDIX

WMD-1

The present strength of the Women Marines Detachment-One is 12 Officers and 209 Enlisted Women (includes 21 WAVES).

PUBLIC WORKS

a. The following projects for the development of the station are in progress:

	AMOUNT
Lengthening of Runways	$6,974,956
Supply Warehouse, preservation Building	1,255,339
Aviation Fuel Storage (Jet Operations)	616,860
Purchase of Diesel Generator	70,368
Purchase of Switchgear and Transformers	246,926
Grading, Paving and Utilities	321,961
Water and Sewer Extension	295,574
Electrical Distribution System (2d Increment)	577,929
Public Works Building	1,080,978
Aircraft Maintenance Hanger (1st Increment) Tactical Area III	1,813,475
Three 333-Man Barracks	1,594,951
Taxiways No. 4 and 5, Tactical Area II	282,000
TOTAL	$15,131,317

b. Construction of 571 rental housing units north of the Station authorized under Title VIII of the National Housing Act, was begun.

MARINE SUPPLY

a. This division maintained control of 12 separate allotments chargeable to Marine Corps appropriations.

b.	Clothing Sales	$108,479.30
c.	Subsistence Commissary (monthly)	114 Tons
d.	Bakery (Bread, Daily)	1,784 Lbs
e.	Commissary Store Sales (monthly)	$108,854.71
f.	Food Service (Four Mess Halls, daily)	5,500 Men
g.	Disbursing Office (MCAS only)	

Military Payrolls	$267,204.55
Civil Payrolls	23,982.79
Public Vouchers	305,817.92

APPENDIX

OPERATIONS

a. Clearance-From 1 July to 31 December 1952, the Clearance Section handled 6,229 VFR flight plans involving 7,295 aircraft and 1,740 IFR flight plans involving 1,904 aircraft. The tower handled 32,437 pre-scheduled flights.

b. Crash -Crew-During the period covered, the Crash Crew handled ten (10) major crashed and seven (7) minor crashes. Four crashes resulted in six fatalities; one on station, a visiting Air Force aircraft, and three off station.

c. Flight

1. Aircraft authorized 14
2. Aircraft assigned 13
3. Total flight time by months

July	1952	391	hours
August	1952	403	hours
September	1952	402	hours
October	1952	226	hours
November	1952	349	hours
December	1952	388	hours
	Total Time	2159	hours

d. Ground Controlled Approach - In the reporting period, 2,463 GCA approaches were made by the Station unit of which 626 were instrument approaches.

e. Air Freight and Passenger -

1.	Flights outgoing	338
2.	Passengers outgoing	5,130
3.	Pounds of freight outgoing	69,383
4.	Pounds of freight incoming	73,636
5.	Pieces of freight handled	1,213

EL TORO	COMMANDING OFFICERS
1 July 1942 -	
- 14 Nov 1945	Col. F. H. Lamson-Scribner
14 Nov 1945 - 22 Feb 1947	Brig.Gen. I. W. Miller
23 Feb 1947 - 5 Mar 1947	Col. Frank M. June
5 Mar 1947 - 1 Jan 1949	Col. Stanley E. Ridderhof
1 Jan 1949 - 13 Jan 1949	Col. Frank M. June
13 June 1949 - 1 July 1949	Col Z. C. Hopkins
1 July 1949 -	Col. Pierson E. Conrad

[illegible]

23 OCT 1956

MEMORANDUM FOR THE DIRECTOR, [illegible] AND MATERIAL DIVISION [illegible]

[illegible]

Ref: (a) [illegible]

Encl: (1) [illegible] 1956 [illegible]

1. Reference (a) requested comment and recommendation [illegible] the Department of Agriculture, US Forest Service, [illegible] constructing a radio aircraft control [illegible] in the Cleveland National Forest, Orange County, California.

2. The special use permit covering:

a. establishing and maintaining [illegible] medium range radio station, [illegible] is approved as to military features.

b. The construction and maintenance of an access road to the site is approved as to military features.

c. development of a spring [illegible] storage tank and installing pipe, is approved as to military features.

3. (U) It is recommended that the aforementioned special use permit be executed by the Chief, Bureau of Yards and Docks on behalf of the Department of the Navy.

4. All papers are returned.

H. O. BRIDGERS, Jr.
Asst Hd, Shore Establishment Programs Branch
Aviation Plans Division

Orig by MAJ J [illegible], Op-504
3 Oct 1956 - X 74188 - [illegible]

(U/S 78053)

El Toro

★

1943 EL TORO 1958

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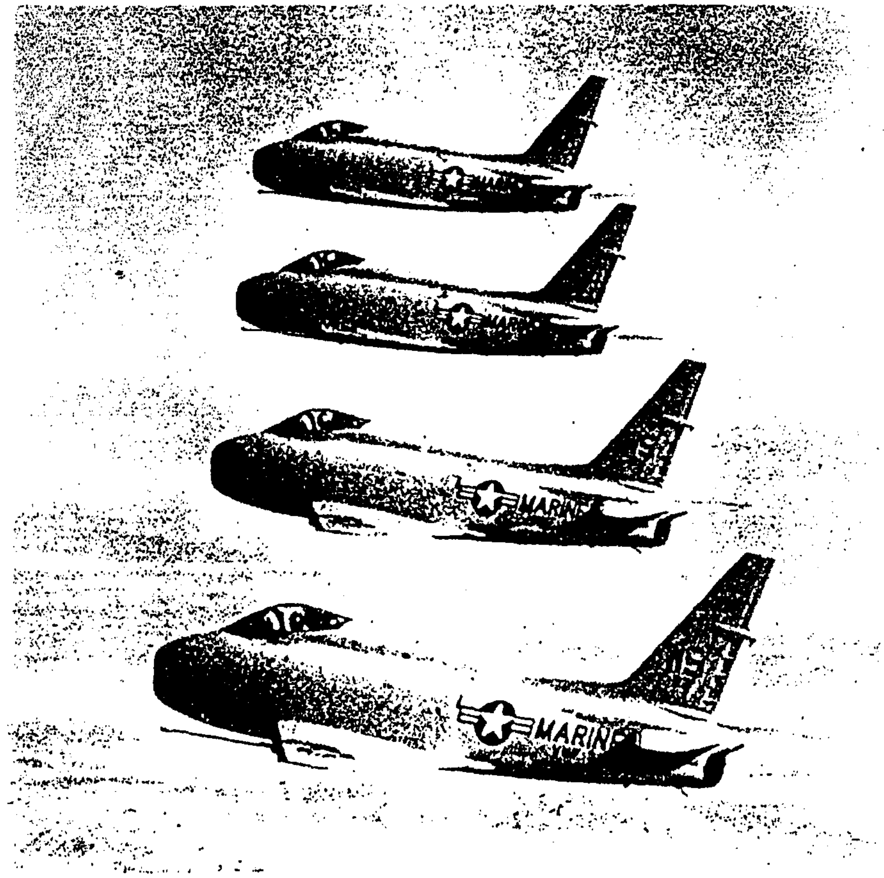
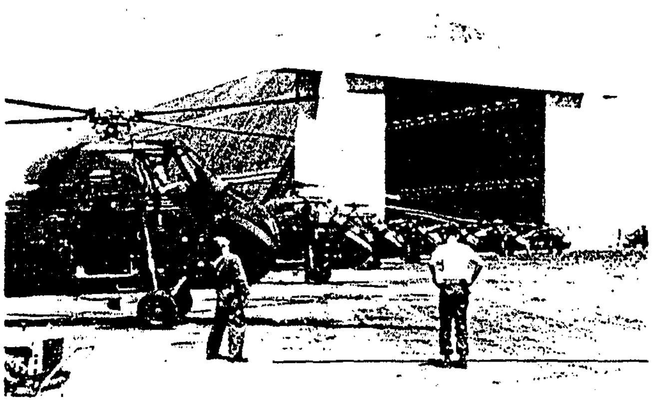


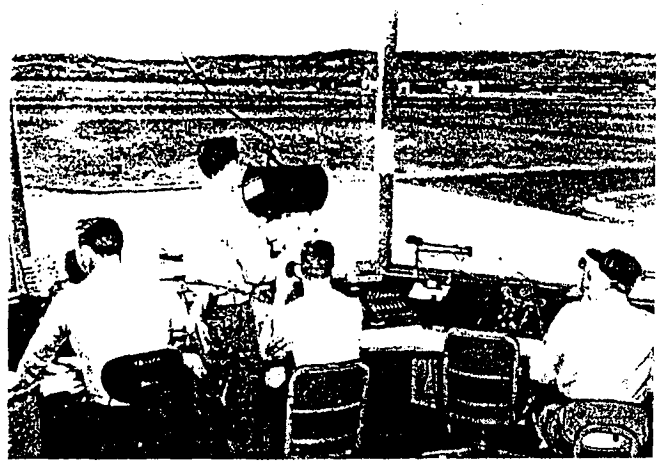
MODERN FURY JETS FLY IN FORMATION OVER MARINE AIR STATION AT EL TORO

In late 1942 a peaceful valley, nestled in the mountains near Santa Ana, California, became a beehive of activity. Giant earthmovers and construction activities covered the 2339-acre tract that had once been fertile farm land. In just a few months, what had once been orange groves and bean fields, became runways, taxiways and aircraft parking space with giant hangars, mess halls, control tower and operations buildings springing up with other facilities that go into making a huge military city. And, on St. Patrick's Day, March 17, 1943, the El Toro Marine Corps Air Station was formally commissioned.

In the early years, thousands upon thousands of Marines poured into the new station. Pilots, fresh from flight training, were given their advance operational training in the Marine Corps' aircraft of that era, the F4U *Corsair*, the SBD *Dauntless* divebomber, the R4D and R5D transports and all the other aircraft that were used by Marine flyers. Aviation ground person-

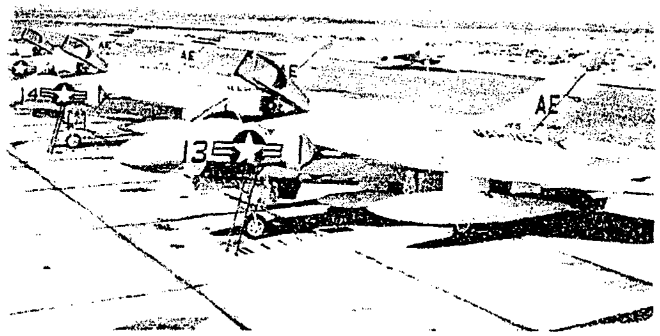


COPTERS ARE USED IN MARINE AERIAL ENVELOPMENT TACTICS



THE BUSIEST SPOT ON THE STATION IS THE OPERATIONS TOWER

CORSAIR WAS ONE OF FIRST PLANES TO OPERATE FROM EL TORO



THE NEWEST JET PUT IN OPERATION IS DOUGLAS F4D SKYRAY

nel became used to round-the-clock training programs and made good their Leatherneck vow "to keep 'em flying."

Although used primarily as a training and staging point for Marine Corps aviation units, El Toro also served as a debarkation point for aviation personnel transferred to Marine combat squadrons in the Pacific. It wasn't long before El Toro earned the name of the "Gateway to the Pacific."

The number of aviation personnel at El Toro increased steadily as the war went on, and the skies overhead became the "Times Square" of western aviation with thousands of aircraft landing and taking off at El Toro. It is the opinion of high ranking military officials that during World War II the Marine Corps Air Station at El Toro had more than "served its purpose."

But El Toro was a temporary wartime installation and shortly after the great war's end the future of the huge base hung in the balance as the armed forces returned to peacetime strength. In fact, there was a question of allowing Orange County's largest military installation to revert to its original state of farmlands when the Korean Conflict broke out. And, with the continued threat of Communist aggression, El Toro was reevaluated as to its need in the future and became a permanent Marine Corps installation.

A PARACHUTE RIGGER CHECKS THE CHUTES

The mission of El Toro today is basically the same as it was 15 years ago. It is used primarily for advanced operational training and as a staging point of Marine Corps aviation units. It is still the gateway to the Far East for all Marine aviation personnel joining the First Marine Aircraft Wing, now in Japan, and other Marine aviation units in the Pacific.

The present Commanding General of El Toro is BGen. Frank H. Wirsig, a veteran Marine Corps pilot, who began his career in 1927.

El Toro is also the "home" of Aircraft, Fleet Marine Force, Pacific, commanded by MGen. Clayton C. Jerome, a veteran of over 35 years Marine Corps service.

From its Headquarters at El Toro, AirFMFPac performs manifold tasks. Its primary function is the training and support of Marine aviation units of the West Coast, the Pacific area and the Far East. It provides trained effective units for amphibious operations of Fleet Marine Forces and Naval forces afloat under direction of task force commanders, as well as for the defense of forward naval bases. It is responsible for effective replacements for carrier-based Marine air units in the Pacific. Its secondary function is to administer and supervise all Marine aviation personnel and activities of its subordinate units for the Pacific area.

The Third Marine Aircraft Wing, also based at El Toro under the command of MGen. Thomas G. Ennis, was commissioned on the anniversary of the Marine Corps, November 10, 1942, at Cherry Point, N. C. After its return from duty in the Pacific in WW II, it was decommissioned; but in 1952 it was recommissioned and based at MCAS MIAMI. In September 1955, the command post was moved to MCAS EL TORO.

The Wing has under its command Marine Aircraft Group 36. MAG-36's helicopters were the first to train from the decks of the USS *Thetis Bay*, the world's first helicopter assault carrier.

El Toro is a complete city with barracks, mess halls, warehouses, swimming pools, riding stables, hospital, chapel, theater, service clubs and Marine Exchange. It has one of the most beautiful 18-hole golf courses in southern California.

Today, approximately 8000 men and women Marines and 1000 civilians, stationed at El Toro, enjoy the facilities that the giant air station has to offer. A friendly relationship between the civilian populace of Orange County and the El Toro Marines has existed since the early days.

To the north of the station lies the mecca of Hollywood and its many tourist delights, to the east are several mountain resorts and to the west are the many sunny Pacific beaches.

Two facilities, the Marine Corps Auxiliary Air Station at Mojave and the Marine Corps Air Facility at Santa Ana, are under the command of BGen. Wirsig, who also is commander, Marine Air Bases, Western Area.

From plows to *Panther* jets in 15 years! Developed from a bean patch, in Orange County to become a modern all-weather air station, El Toro has a big place in national defense.

The Radar Station will be an air-conditioned 133' by 50' concrete block reinforced single story structure. It will house eight electronic technicians, a mess NCO, and one medical corpsman. This construction work is being done by the Viking Co., of Covina, Calif.

One of the largest contracts to be let so far is the extension of runway 16L-34R here at El Toro, plus the installation of the approach lighting system and construction of the optical landing system. This contract was let to the Gordon H. Ball Inc., Danville, Calif., and will cost $2,074,000.

Specifications on the runway will be 55,556 square yards of reinforced Portland cement concrete, 13 inches thick over a 10 inch select base over 12 inches of native material, scarified and compacted to 95%. The taxiways have 68,795 square yards of 11 inches of reinforced Portland cement concrete over a 10 inch base.

The electrical contract on the runway extension was let to the Newbery Electric Corp., Santa Ana, Calif.

All construction is under the direct supervision of Captain W. M. Johnson, CEC, USN, presently living at FOQ-18 here, El Toro's Resident Officer in Charge of Construction and his assistant Lieutenant A. C. Beard, CEC, USN, 2692 Redlands Dr., Costa Mesa. Projects Engineer for the construction program is J. E. Davis of 1609 N. Rosewood, Santa Ana.

INFORMATIONAL SERVICE OFFICE
MARINE CORPS AIR STATION
EL TORO (Santa Ana) CALIFORNIA
LI 4-1230, EXT. 431-433-1039

EL TORO MARINE CORPS AIR STATION, Aug. 19 -- The El Toro Marine Corps Air Station, Santa Ana, Calif., is presently undergoing a giant face-lifting which will make it one of the largest and most comprehensive military air stations in Southern California.

Three of the giant construction jobs have already begun with the completion dates set for the summer of 1959:

The three jobs are; construction of four, three story permanent type barracks for enlisted men; the extension of one of the aircraft runways plus installation of the approach lighting system and construction of an optical landing system; and construction of a medium range radar air traffic control center. The three jobs will cost a total of approximately $4,000,000.

The new enlisted men's barracks will house 252 men and have an approximate area of 8300 square feet including dormitory, restrooms, non-commissioned officers quarters and office facilities. There will also be a 260' by 380' parking area and fences, sidewalks and selected landscaping are included in the contract. The contractor is Wells Benz Inc., of Phoenix, Ariz.

The second contract let is the construction of a medium range radar air traffic control center located in Pleasant Peak in the Cleveland National Forest, an elevation of approximately 4000 feet. This new Radar Control Center will provide coverage on all air traffic within a 100 mile line of sight of 50,000 foot altitude. Control can be effected to feed as many as three aircraft into the final approach pattern simultaneously.

-more-stations of compariable size.

Public Works:

The giant Public Works Department at El Toro operates with ten separate sections and handles everything from the repairing of typewriters to large construction jobs. At the present time there are 495 personnel in Public works, of which 416 are civilians.

Station Operations:

It falls to the responsibilities of the Station Operations to handle all the incoming and outgoing aircraft at El Toro. Firgures based on an eight hour day, five days a week, this department handles on an average of 9000 operations a month. Within the Station Operations is the Air Freight Section. Last year this section handled over 20,000 passengers, 50,000 pounds of cargo and 800,000 pounds of baggage.

Utilities:

It takes many factions to keep a station the size of and warehouses dot nearly every area.

Dependent Housing:

El Toro has ~~three~~ seven dependent housing areas. NAMAR (Navy-Marine) Housing consists of 280 low-cost furnished units for enlisted personnel.

Public Quarters, formerly Master Sergeant Quarters on Station, is now open to Sergeants with seven years service and above, consists of 50 furnished duplexes and eight two-bedroom furnished apartments.

Temporary Quarters for officers consists of 18 furnished Quonset Huts.

Field Officers' Quarters consists of 50 three-bedroom homes; furnished or unfurnished.

Generals' Quarters consists of two four-bedroom homes.

Junior Officers' Quarters consists of 12 two and three bedroom apartments.

Wherry Park, located just outside Gate #2 of the Station

ADDITIONAL FACTS ABOUT THE MARINE CORPS AIR STATION, El Toro.

The Marine Corps Air Station, El Toro, Calif., consists of a total of 4,412.75 acres. Of this, 3,876.65 acres are Navy owned, an easement of 27.85 acres and 508.25 acres are under lease. There is 43,050 lineal feet of fencing surrounding the boundary areas of the Station.

Runways:

El Toro has a total of five runways, the longest of which is 8,000 feet and the shortest is 6,312 feet. These are all asphalt runways 250 feet wide. There are 29 taxiways, 20 of which are asphalt and nine of concrete.

Buildings:

There are 16 hangers, 41 squadron and group administrative buildings, 39 enlisted barracks, 17 bachelor officer quarters, 14 instruction and training buildings, 13 buildings for messing facilities, 11 Marine Corps Air Station administrative buildings and 26 personnel service buildings. Storage areas

(Encl(2) to CG,MCASltr) -more-consists of a total of 571 units. There are 378 for enlisted and 193 for officers. These are as follows:

226 duplex apartments, two-bedroom, for enlisted.
116 duplex apartments, three-bedroom, for enlisted.
87 individual homes for junior officers.
28 duplexes for junior officers, 2&3 bedrooms.
42 apartments for junior officers, one bedroom.
36 quadruple apartments buildings for enlisted.
36 individual homes, 2&3 bedrooms, for field officers.

<u>Navy Supply Department:</u>

El Toro is also home of one of the three Navy Supply Departments located at Marine Corps Air Stations. The other two are located at MCAS, Cherry Point and MCAS, Miami, Fla. The Navy Supply Department here handles over 80 thousand different items from the smallest of airplane bolts to the very flight gear worn by the pilots. Navy Supply expenditures in Orange and Los Angeles Counties alone runs over 2 million dollars annually. The giant department, in addition to its military personnel, also employs nearly with an annual payroll of one million dollars. The Navy Supply Department has been at El Toro since 1943 and has grown from just a tent to six huge warehouses that hold over $28,000,000 in stock.

Fuel:

The jet aircraft at El Toro consume approximately 4,000,000 gallons of JP-4 fuel monthly. The fuel is brought into El Toro through an eight inch pipeline that extends from the El Toro Station to Norwalk, Calif., 29 miles away.

Fire Department:

The fire Department at El Toro is maintained by 41 civilian firemen and they operate out of two fire stations with three engine companies. Their equippment is four, 750 gallon pumper trucks, one 500 gallon pumper truck and three other type vehicles. Each member of the department has to attend at least four hours of instructions a week plus they also conduct instruction periods for El Toro personnel. Fire loss at El Toro is one of the lowest in the United States of

El Toro Facts-6-6-6

El Toro operating smoothly. A few of these is water, electricity, and heating and cooking facilities. El Toro uses over 500,000,000 gallons of water a year which is brought from Boulder Dam in Colorado. It is pumped into the Station by three 75 horse power pumps. El Toro also uses over 1,800,000 kilowatt hours of electricity a month and 14,800 gallons of propane gas and 53,000 of fuel oil for heating and cooking purposes.

APPENDIX X

EXTRACT
FINAL BRACCLEANUP PLAN
HISTORY OF INSTALLATION OPERATIONS
MARCH, 1999

Table 1-2
History of Installation Operations
(Sheet 1 of 3)

Period	Type of Operation	Weapon System	Hazardous Substance Activity	Map Reference[1]
Pre-1943	Agricultural	None	Potential pesticide use	VL
1943	New construction MCAS El Toro formally commissioned	None	Construction Landfilling STP and sludge drying beds Fuel/oil/chemical storage Discharge to washes Waste burning	VL 1 2 VL 3 8
1943 to 1945	465 aircraft assigned (F4U, TBM, R5C, C-54, SNJ) 15,470 personnel assigned	Fighter, Bombing, and Training Aircraft	Construction Landfilling Fuel/oil/chemical storage STP and sludge drying beds Discharges to washes UST petroleum/waste storage Oil/water separators Aircraft refurbishing operations Waste burning IWTP	VL 1 VL 2 3 VL VL 4 8 9
1946 to 1952	Marine aircraft groups assigned Aircraft (F4U, F7F, TBM, C-54, SNJ) 4,000 personnel assigned	Fighter, Bombing, Transport, and Training Aircraft	Petroleum disposal area Landfilling Fuel/oil/chemical storage STP and sludge drying beds Discharges to washes UST petroleum/waste storage Oil/water separators Aircraft refurbishing operations Waste burning IWTP	5 1 VL 2 3 VL VL 4 8 9
1952 to 1955	Aircraft fleet marine force assigned Marine aircraft groups assigned Aircraft (F3D, F9F, F6F, C-119, C-54, AD, HRS)	Fighter, Attack, Transport, Training Aircraft, and Helicopters	Explosive ordnance disposal Petroleum disposal area Landfilling Fuel/oil/chemical storage STP and sludge drying beds Discharges to washes UST petroleum/waste storage Oil/water separators Waste burning IWTP	6 5 1 VL 2 3 VL VL 8 9
1955 to 1960	One marine air wing (3d MAW relocated to MCAS El Toro from Miami, Florida) Aircraft (AD, A4D, F3D, F4D, F8U, F9F, C-119, C-54)	Fighter, Attack, Transport, Photographic, Reconnaissance, and Tanker Aircraft	Explosive ordnance disposal Petroleum disposal area Landfilling Fuel/oil/chemical storage STP and sludge drying beds Discharges to washes UST petroleum/waste storage Oil/water separators Waste burning IWTP	6 5 1 VL 2 3 VL VL 8 9

Table 1-2
History of Installation Operations
(Sheet 2 of 3)

Period	Type of Operation	Weapon System	Hazardous Substance Activity	Map Reference[1]
1961 to 1975	One marine air wing (3d MAW) Aircraft (AD, A4D, F4H, C-130) 8,600 personnel assigned	Fighter, Attack, and Tanker Aircraft	Explosive ordnance disposal Petroleum disposal area Landfilling Fuel/oil/chemical storage STP and sludge drying beds Discharges to washes UST petroleum/waste storage Oil/water separators Fire training area burn pits	6 5 1 VL 2 3 VL VL 7
1976 to 1985	One Marine Air Wing (3d MAW) Aircraft (A4D, F4H, C-130)	Fighter, Attack, and Tanker Aircraft	Explosive ordnance disposal Petroleum disposal area Landfilling Fuel/oil/chemical storage Discharges to washes UST petroleum/waste storage Oil/water separators Fire training burn pits	6 5 1 VL 3 VL VL 7
1986 to 1991	One Marine Air Wing (3d MAW). Includes: MAG -11 90 F/A-18 fighter attack aircraft 12 KC-130 MAG -46 12 F/A-18 fighter attack aircraft 12 aircraft (CH-46) Station 3 aircraft (UH-1) 3 aircraft (UC-12) 1 aircraft (CT-39) 7,200 personnel assigned	Fighter, Attack, and In-flight Refueler Aircraft, Helicopters and Logistic Transport	Petroleum disposal area Fuel/oil/chemical storage Discharges to washes UST petroleum/waste storage Oil/water separators Fire training burn pits	5 VL 3 VL VL 7
1991 to 1995	One Marine Air Wing (3d MAW). Includes: MAG -11 125 F/A-18 fighter attack aircraft 12 KG-130 MAG -46 12 F/A-18 fighter attack aircraft (Reserve) 12 CH-46 helicopters Station UH-1 search and rescue helicopter UC-12, CT-39 logistic aircraft 8,000 personnel assigned	Fighter, Attack, and In-flight Refueler Aircraft, Helicopters and Logistic Transport	Fuel/oil/chemical storage Discharges to washes UST petroleum/waste storage Oil/water separators Petroleum disposal area Fire training burn pits	VL 3 VL VL 5 7

Table 1-2
History of Installation Operations
(Sheet 3 of 3)

Period	Type of Operation	Weapon System	Hazardous Substance Activity	Map Reference[1]
1995 to present	One Marine Air Wing (3d MAW). Includes: MAG -11 42 F/A-18 fighter attack aircraft 2 T-34C trainer aircraft 14 KC-130 aerial refueler/transport aircraft MAG -16 84 CH46 transport helicopters VMR-2 3 UH-1 search and rescue helicopters 3 UC-aircraft 1 CT-39 logistic aircraft; MAG-46 12 CH-46 (reserve) helicopters 9 CH-53 (reserve) helicopters (PAA for 8) actually do not have a home 5,546 personnel assigned (civilians included)	Fighter, Attack, and In-flight Refueler Aircraft, Helicopters and Logistic Transport	Fuel/oil/chemical storage Discharges to washes UST petroleum/waste storage Oil/water separators Petroleum disposal area Fire training burn pits	VL 3 VL VL 5 7

Sources:

MCAS El Toro Master Plan, 1991
MCAS El Toro & Tustin Unofficial Guide and Directory, 1992
MCAS El Toro Command Museum Personnel

Notes:

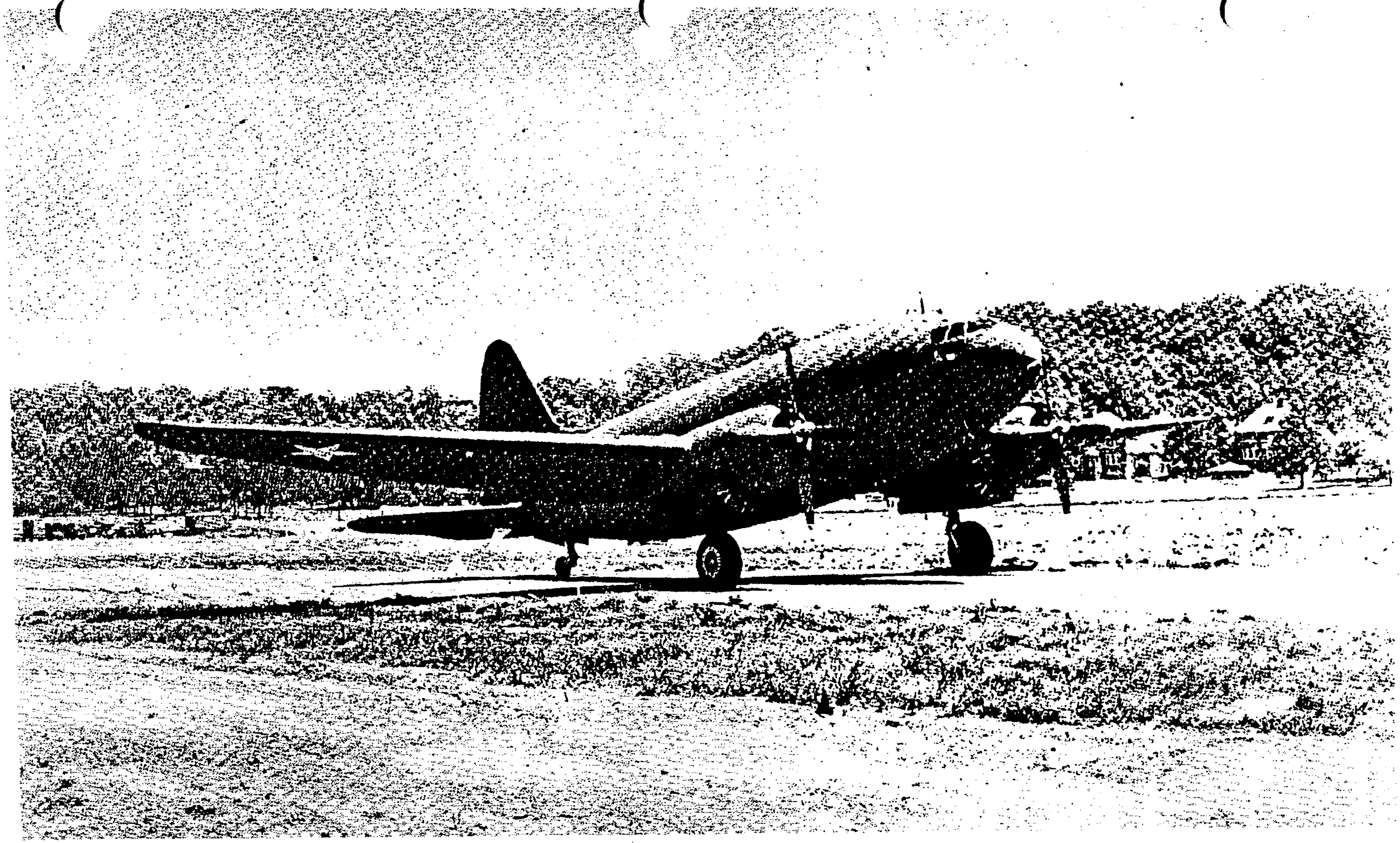
1 Reference numbers correspond to locations shown in Figure 1-2

Abbreviations:

VL = various locations
STP = sewage treatment plant
UST = underground storage tank
IWTP = industrial wastewater treatment plant

APPENDIX Y

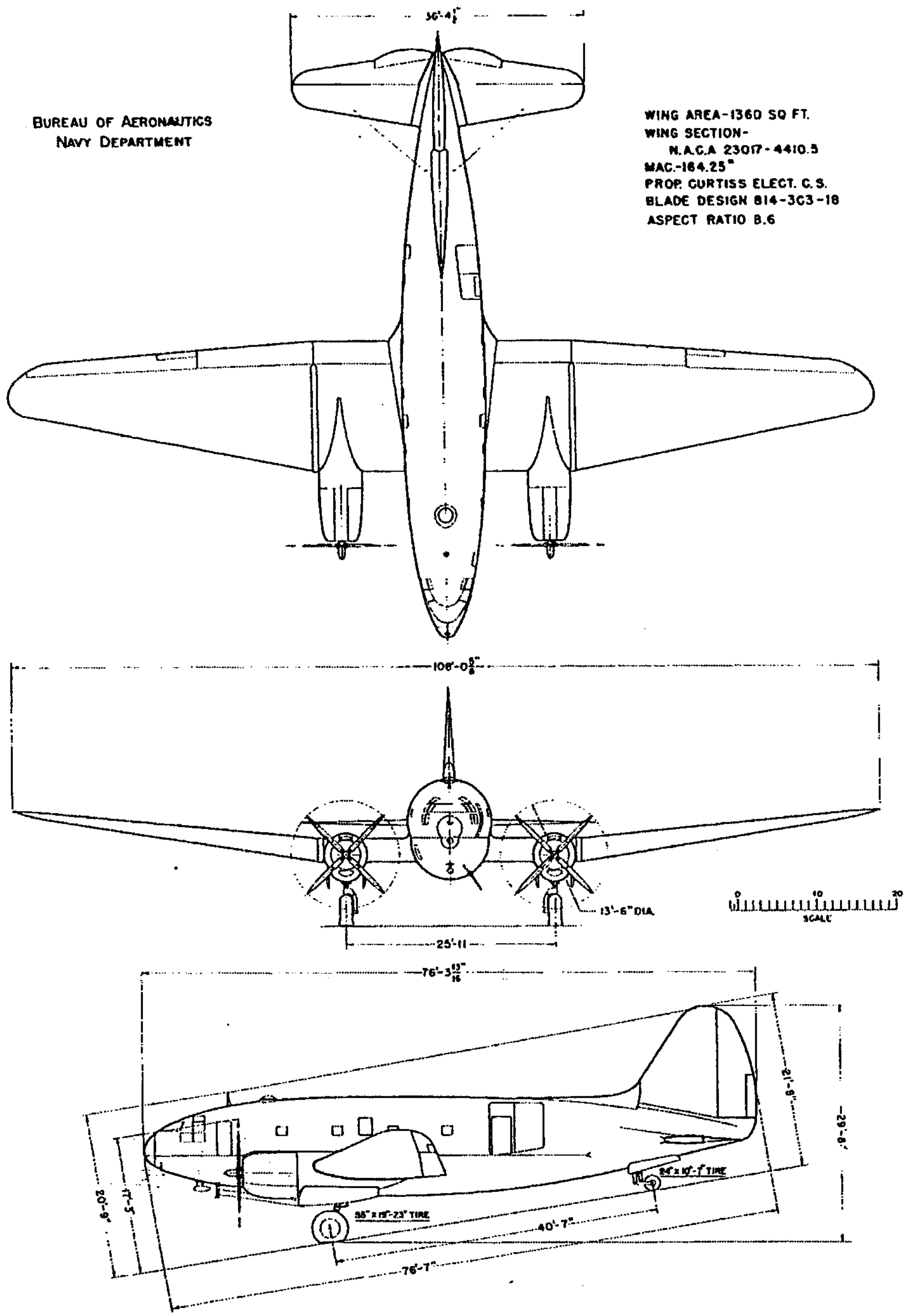
DESCRIPTIONS OF MILITARY AIRCRAFT ASSIGNED OR ATTACHED TO MCAS, EL TORO OPERATIONS



STANDARD AIRCRAFT CHARACTERISTICS

R5C-1 "COMMANDO"

Bureau of Aeronautics
Navy Department



Descriptive Arrangement

MISSION AND DESCRIPTION

The Curtiss "Commando" R5C-1 is a troop-cargo transport, similar to the Air Force C-46A, for medium-range hauls. It was used in the C.B.I. theatre by the Air Forces for over the "Hump" air lift, and extensively by the Marine Corps in the Central Pacific, North China and Japan. The airplane is of conventional design and construction. The wing carries Frise-type ailerons and rearward-moving slotted flaps hydraulically actuated. De-icer shoes may be fitted. Ailerons and elevator controls contain boosters, and rudder and elevator are fitted with spring-tabs. The fuselage cargo door is 78.5" high forward, 66.5" high aft, and 95.5" wide.

DIMENSIONS

SPAN..................108'-0"
LENGTH................76'-4"
HEIGHT................21'-8"
WING AREA........1360 sq. ft.
M.A.C.................164.3"
TREAD.................25'-11"

WEIGHTS

Loadings	Lbs.	L.F.
EMPTY	30,241	
BASIC	31,828	
DESIGN	46,000	2.67
MAX. T.O.	52,000	2.52
MAX. LAND.	52,000	

All weights are actual.

FUEL AND OIL

Gals.	No. Tanks	Location
1400	6	Wing
1600	16	Fuselage

FUEL GRADE.....100/130
FUEL SPEC......AN-F-48

OIL

CAPACITY (gal.).........120
SPEC................. AN-O-8
GRADE........... 1120-1100

ELECTRONICS

COMMAND.............SCR-274-N or SCR-522
LIAISON.............SCR-287-A
COMPASS.............SCR-269-G or AN/ARN-7 or MN-26-C
MARKER BEACON REC......RC-43B
GLIDER INTERPHONE..AN/AIA-1A
GLIDEPATH REC......AN/ARN-5A
ALTIMETER............SCR-518 or AN/APN-1

POWER PLANT

NO. & MODEL......(2) R-2800-51
MFR..................P. & W.
SUPERCH......1 Stage, 2 Speed
PROP.GEAR RATIO...........2:1
PROP. MFR.............Curtiss
PROP.DES.NO........814-3C3-18
NO.BL./DIA..........4/13'-6"

RATINGS

	Bhp.	RPM.	@Alt.
T.O.	2000	2700	S.L.
NORMAL	1600	2400	S.L. to 5700'
	1450	2400	13000'

SEE NOTE

SPEC NO. A-8035-D

ORDNANCE

Max. package size
90" x 60" x 80"

Max. Payload.........10,000#
100 psf....floor load,Fwd.
200 psf....floor load,aft.
31 psf....floor load,lower

LOADING CONDITION		CARGO - TROOP TRANSPORT	(2) CARGO - TROOP TRANSPORT	(3) CARGO - TROOP TRANSPORT	
TAKE-OFF WEIGHT	lbs	52000	45000	48000	
Fuel	lbs	8838	8838	8838	
Bombs	lbs				
PAYLOAD	lbs	10000	3000	6000	
Wing/Power Loading (A)lbs/sq.ft.lbs/	bhp	38.2/17.9	33.1/15.5	35.3/16.6	
Stall Speed--Power off	kn	76.6	71.2	73.6	
Stall Speed--Power off - No Fuel	kn	69.8	63.8	66.5	
Stall Speed--Power on	kn				
Maximum Speed/Alt (B)	kn/ft	227/16000	233/16100	230/16000	
Take-off Distance, deck -- calm	ft	1900	1300	1540	
Take-off Distance, deck kn.	ft				
Take-off Distance, Airport (50 ft.)	ft	4900	3160	3850	
Rate of climb -- sea level (B)	ft/min	595	830	720	
Service Ceiling (B)	ft	18000	20600	19300	
Time-to-climb 10000 ft. (B)	min	19.2	13.3	15.5	
Time-to-climb 20000 ft. (B)	min		38.6		
Combat Range/V av 1500 ft.	n.mi/kn	1665/135	1960/121	1750/129	
Combat Radius/V av ft.	n.mi/kn				
LOADING CONDITION					
GROSS WEIGHT	lbs				
Engine power					
Fuel	lbs				
Bombs/Tanks					
Max. speed at sea level	kn				
Max. speed ft.	kn				
Combat speed/Alt.	kn/ft				
Rate of climb SL	ft/min				
Ceiling for 500 fpm R/C	ft				
Time-to-climb/Alt.	min/ft				

NOTES

(A) BHP at Maximum Critical Altitude
(B) Normal BHP

Performance is based on flight test of the R5C-1 airplane. Range is based on engine specification, fuel consumption data increased by 5%.

Maximum combat range is reduced by generator limitations which restrict operation below 1600 RPM.

NOTES

Provisions for 40 troop seats or 24 litter patients are incorporated.

Performance includes the effect of de-icer boots. Removal of de-icer boots increases Vmax at ACA by 4.5 knots and maximum combat range at 1500 ft. by 3%.

Performance with one engine inoperative, propeller feathered, landing gear and flaps retracted is estimated to be:

Gross Weight..50000#
Rate of Climb - S.L. - T.O. Power........................110 Ft./Min.
Service Ceiling (normal power) is 1000 ft. at 42300#

---

100 gallons auxiliary fuel tanks may be installed in pairs in the main cabin, up to 1600 gallons.

Engine ratings from Flight Test:

	Bhp.	Rpm.	Alt.
T.O.	2000	2700	S.L.
Mil.	2000	2700	1500'
	1600	2700	13500'
Norm.	1600	2400	6100'
	1450	2400	14000'

NAVAL AIRCRAFT

AVE

The TBF was designed in response to a Navy invitation for new designs for a torpedo bomber to replace the TBD *Devastator*. In April 1940, a contract was issued for two prototype XTBF-1s. First flight was August 7, 1941. The first public look at the plane was scheduled for December 7. That day's events led to naming the new aircraft *Avenger*.

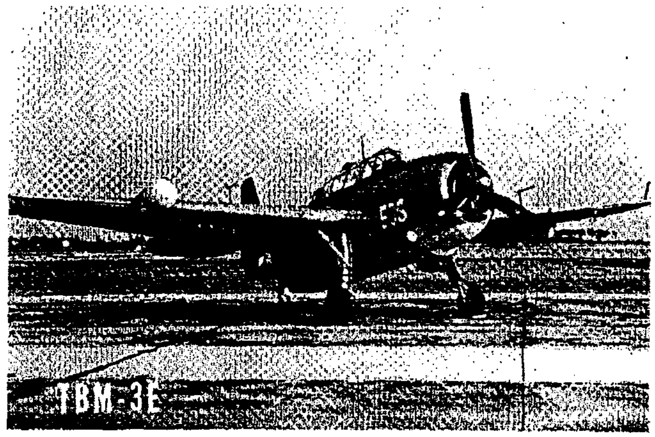
In December 1940, one year before U.S. entry into WW II, a production contract was ordered and TBF-1s began rolling off Grumman's assembly lines soon after. Among these early models were some assigned to Torpedo Squadron Eight. Though they did not reach the Pacific in time to join VT-8's TBDs on *Hornet*, six participated in the Battle of Midway from that island's airfield.

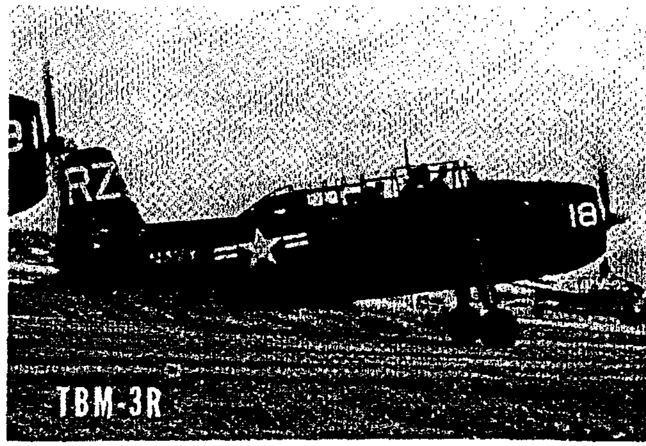
In November 1942, Eastern Aircraft, a division of General Motors, began delivering the first TBM-1s, supplementing *Avenger* production, and, in December 1943, Grumman discontinued building TBFs to concentrate on producing the F6F *Hellcat*.

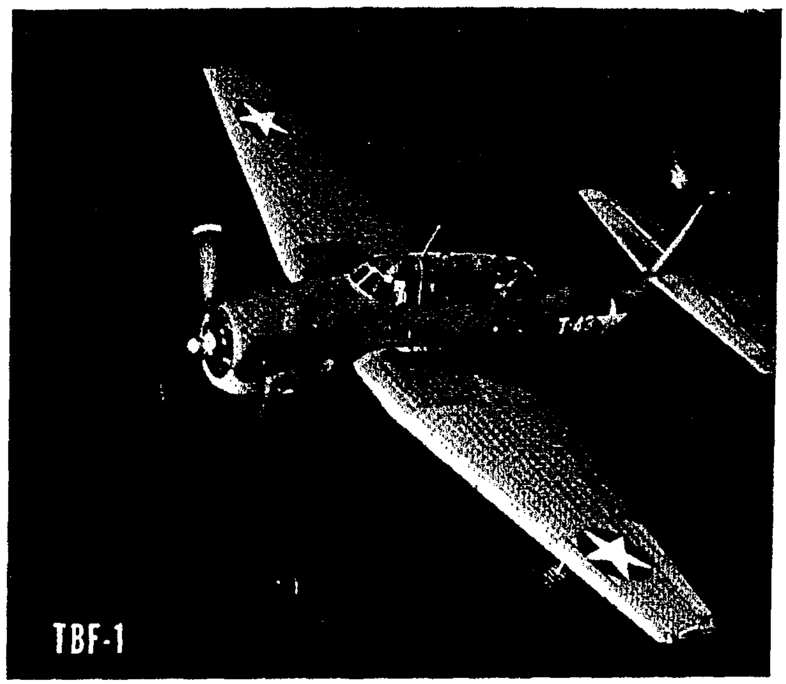
The *Avenger* was produced in many versions, the most numerous being the TBF-1 and TBM-1. Other models included the TBF-1C and TBM-1C with two wing-mounted .50 cal. guns; followed by versions with special radar; with cameras for photo recon and with searchlights for ASW. The TBM-3 with more powerful engines replaced the -1 series in production. Versions were built or modified including -3Es with improved radar; the first carrier AEW airplane; and ASW, utility, ECM and COD models.

The *Avenger* made its name in WW II as a rugged torpedo plane used effectively against surface vessels in the Pacific and from CVEs in the Atlantic as an ASW attack plane.

Avengers also served with the Royal Navy, Royal New Zealand Air Force and French Navy. Ironically, the last TBMs to be retired from active service, in 1962, were flown by the Japanese Maritime Self Defense Force.



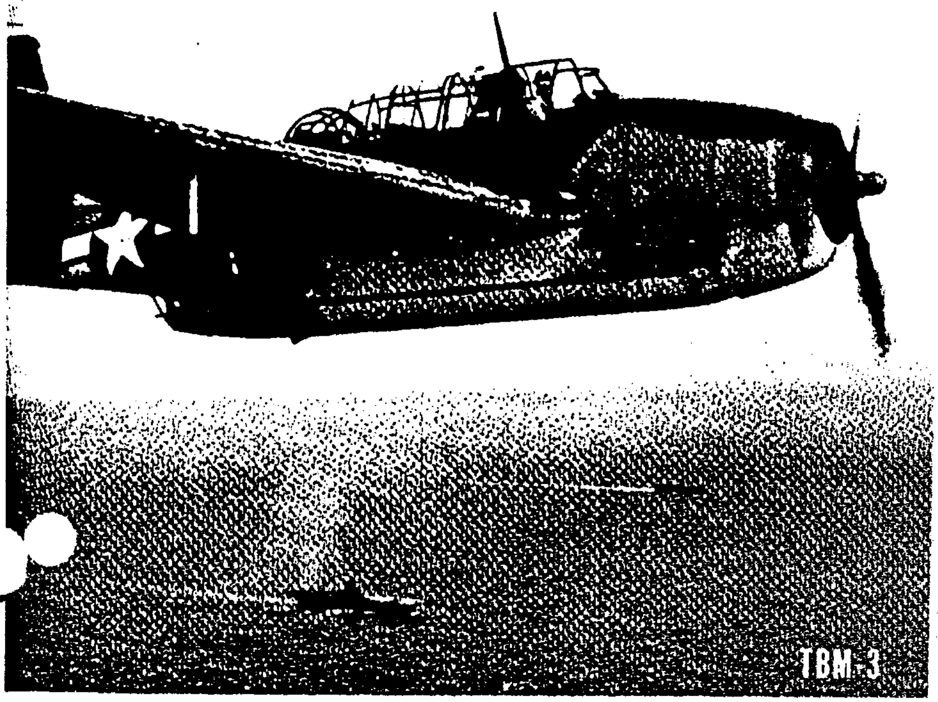




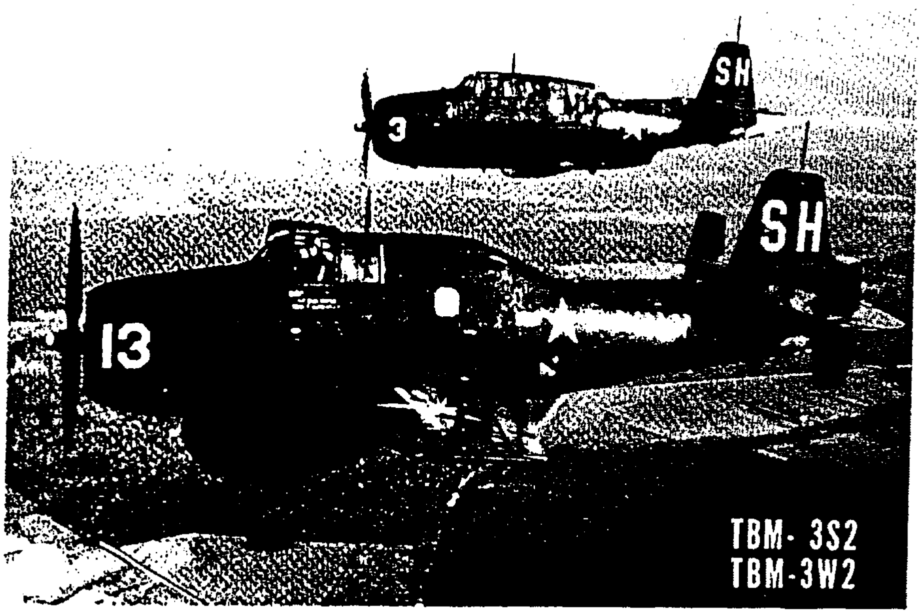
NGER

TBF/TBM

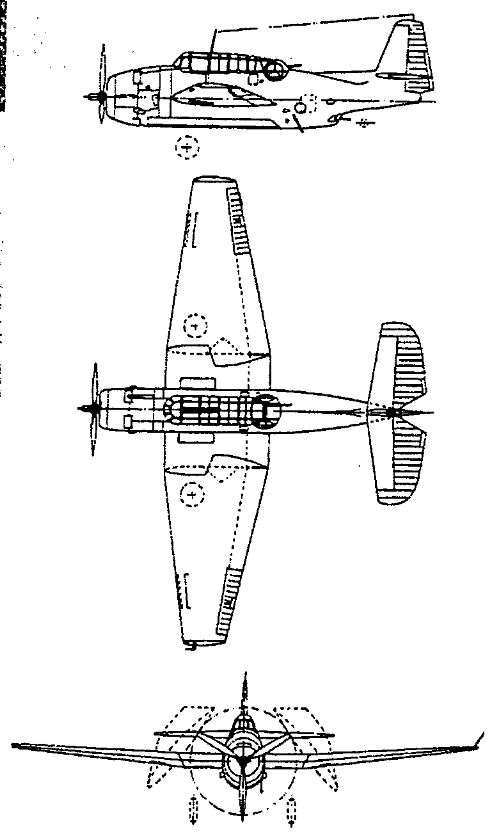
Length	40'11½"
Height	16'5"
Wing span	54'2"
Power plant	
TBF-1	R-2600-8 1,700 hp
TBM-3E	R-2600-20 1,900 hp
Maximum speed	
TBF-1	232 kts
TBM-3E	220 kts
Cruising speed	
TBF-1	[illegible] kts
TBM-3E	125 kts
Service ceiling	
TBF-1	22,400
TBM-3E	27,100
Maximum range	
TBF-1	1,055 nm
TBM-3E	880 nm
Armament	
TBF-1	one fixed cowl-mounted .30 cal, one dorsal .50 cal, one ventral .30 cal, 1,600 lbs in bomb bay
TBM-3E	two fixed wing .50 cal, one dorsal .50 cal, one ventral .30 cal, 2,000 lbs in bomb bay
Crew	pilot, gunner, radar operator



TBM-3



TBM-3S2
TBM-3W2



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DECLASSIFIED

NAVAER ISSUE OF 6 PAGES

AIRPLANE CHARACTERISTICS & PERFORMANCE

BUREAU OF AERONAUTICS-NAVY DEPT.

COLUMN NUMBER	1	2	3	4
LOADING CONDITION	TORPEDO 1-MK13-2	TORPEDO 1-MK13-2	TORPEDO 1-MK13-2 TWO TANKS EXTERNAL	BOMBER 4-500#
GROSS WEIGHT LBS.	16412	16412	17364	16425
EMPTY WEIGHT (ACTUAL) LBS.	10555			
FUEL/OIL GALS.	335/19	335/19	451/25	335/19
FIXED. GUNS/AMMUNITION	2-.50/400 rds		2-.50/600 rds	
FLEXIBLE GUNS/AMMUNITION	1-.50/200, 1-.30/500		1-.50/400, 1-.30/500	
ENGINE POWER USED FOR PERFORMANCE	MILITARY	NORMAL	NORMAL	NORMAL
WING LOADING LBS/SQ.FT.	33.4	33.4	35.4	33.4
POWER LOADING ① LBS/BHP.	11.3	12.1	12.8	12.1
V-MAX. SEA LEVEL MPH.	249	238	227	238
V-MAX. AIRPLANE CRIT. ALT. MPH.	257/12000	254/11700	241/11700	254/11700
V-STALL. GROSS WEIGHT. ② MPH.	76.9	76.9	79.2	77.0
V-STALL. WITHOUT FUEL ② MPH.	72.0	72.0	72.6	72.0
TIME-TO-CLIMB -10000FT.- MIN.		13.0	15.9	13.0
TIME-TO-CLIMB -20000FT.- MIN.		41.6	59.7	41.9
SERVICE CEILING FT.	21400	20900	19400	20900
TAKE-OFF DISTANCE -CALM- FT.		1071	1383	1076
TAKE-OFF DISTANCE -15 KN- FT.		650	850	653
TAKE-OFF DISTANCE -25 KN- FT.		435	563	438
TAKE-OFF TIME SECONDS.	-	-	-	-
MAX. RANGE/V-AV. ③ ST.MI/MPH.		1105/153	1390/152	1105/153
BOMBING RADIUS/V-AV.-20% R.- NMI/KN.				
BOMBING RADIUS/V-AV.-33% R.- NMI/KN.				
PATROL RADIUS/V-AV.-20% R.- NMI/KN.				
PATROL RADIUS/V-AV.-33% R.- NMI/KN.				
SCOUT. RADIUS NMI.				
COMBAT RADIUS NMI.		225	340	225
ENGINE/PROP. GEAR RATIO	W.A.C. R-2600-8 (16:9)			
ENGINE RATING BHP/RPM/ALT.	NORMAL: 1500/2400/SL-5800; 1350/2400/8900-13000		MILITARY: 1700/2600/SL-3000; 1450/2600/7800-12000	
	1700/2600/Take-off			

NOTE STATUTE MILES USED-EXCEPT-RADIUS IS GIVEN IN NAUTICAL MILES & KNOTS.
① BHP AT MAX. CRIT. ALT. ② STALL-WITHOUT POWER ③ AT 5000' ALTITUDE

	TANKAGE IN GALLONS	OIL	FUEL	OFFENSIVE ARMAMENT
FIXED	PROTECTED	32	335	Fuselage Bomb Bay
FIXED	UNPROTECTED			Torpedoes: 1 MK13-1, or -2
FIXED	TOTAL-INCL. PROT.	32	335	Bombs : 1-1600#, 1-1000#
FIXED	INCREASE-REMOVED PROTECTION (Not Removable)			4-500#, 12-100#
AUX.				D. Bombs : 1-650# or 4-325#
AUX.				NOTE: Torpedoes or Bombs can not
AUX.	DROPPABLE Bomb Bay (Unprot.)		275	be carried if internal
AUX.	DROPPABLE Wing: 2@ 58 (Unprot.)		116	droppable tank is installed.
	PROTECTED+UNPROTECTED+DROPPABLE.	32	726	

REMARKS- Ferry Range is 2685 miles with gross weight 15770 lbs.; 726 gals. fuel; and having ASB, Guns, Ammunition and Armor removed.
TBF-1 & TBM-1 have only 1-.30 cal. fixed gun & are 354 lbs. lighter for max. ammunition load conditions. Weight & Performance given for -1C Model.

SUPERSEDES 8/8/42

ALSO TBM-1C & -1

NAVAER
AIRPLANE CHARACTERISTICS & PERFORMANCE — BUREAU OF AERONAUTICS-NAVY DEPT.

COLUMN NUMBER	5	6	7	8
LOADING CONDITION	BOMBER 1-1000#	SCOUT	SCOUT	SCOUT
GROSS WEIGHT LBS.	15422	14358	16334	17121
EMPTY WEIGHT (ACTUAL) LBS.	10555			
FUEL/OIL GALS.	335/19	335/19	610/32	726/32
FIXED GUNS/AMMUNITION	2-.50/600			
FLEXIBLE GUNS/AMMUNITION	1-.50/400, 1-.30/500			
ENGINE POWER USED FOR PERFORMANCE	NORMAL	NORMAL	NORMAL	NORMAL
WING LOADING LBS/SQ.FT.	31.4	29.3	33.3	34.8
POWER LOADING (1) LBS/BHP.	11.4	10.6	12.1	12.7
V-MAX. SEA LEVEL MPH.	239	241	238	228
V-MAX. AIRPLANE CRIT. ALT. MPH.	256/11700	258/11700	254/11700	242/11700
V-STALL. GROSS WEIGHT. (2) MPH.	74.6	72.0	76.8	78.6
V-STALL. WITHOUT FUEL (2) MPH.	69.5	66.8	67.6	67.8
TIME-TO-CLIMB -10000FT.- MIN.	10.9	9.2	12.8	15.1
TIME-TO-CLIMB -20000FT.- MIN.	32.5	25.8	41.0	54.2
SERVICE CEILING FT.	22200	23600	21000	19600
TAKE-OFF DISTANCE -CALM- FT.	880	718	1055	1285
TAKE-OFF DISTANCE -15 KN- FT.	520	418	640	796
TAKE-OFF DISTANCE -25 KN- FT.	340	262	428	532
TAKE-OFF TIME SECONDS.	-	-	-	-
MAX. RANGE/V-AV. (3) ST.MI/MPH.	1180/148	1300/142	2135/149	2335/146
BOMBING RADIUS/V-AV.-20% R.- NMI/KN.				
BOMBING RADIUS/V-AV.-33% R.- NMI/KN.				
PATROL RADIUS/V-AV.-20% R.- NMI/KN.				
PATROL RADIUS/V-AV.-33% R.- NMI/KN.				
SCOUT. RADIUS NMI.		340	580	645
COMBAT RADIUS NMI.	235			

PERFORMANCE IS BASED ON- Flight Test
RANGE & RADIUS ARE BASED ON Flight Test FUEL CONSUMPTION DATA INCREASED BY 5 PERCENT TO CONFORM WITH PAST EXPERIENCE.

Practical combat radius is based on 20 min. warm-up and idling; 1 min. take-off; 10 min. rendezvous at 60% normal sea level power (n.s.p.) and auto-rich; climb to 15000' at 60% n.s.p. and auto-lean unless auto-rich is required for cooling; cruise out at 15000' at 60% n.s.p. and required mixture; dive, drop bombs, torpedoes and external tanks; combat at 1500' for 5 min. with full military power plus 10 min. with full normal power; cruise-back at 1500' at 60% n.s.p. and auto-lean; 60 min. rendezvous, landing and reserve at V for max. range and auto-lean. Radius includes distance covered in climb but not in dive.

Practical scouting radius is 1/3 of range at V for max. range at 1500' with fuel taken out for 20 min. warm-up and idle, 1 min. take-off and 60 min. for rendezvous, landing and reserve.

The following changes are incorporated: Contract - thru AQ; Service - thru #121; Pending - (1) 2-.50 Cal. wing guns installation (2) provisions for 2-58 gal. droppable wing tanks.

Col. (7) - Internal Droppable Fuel Tank Installed.

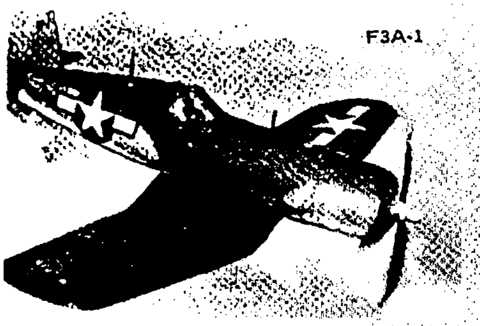
Col. (8) - Internal Droppable & Wing Droppable (2) Fuel Tanks Installed.

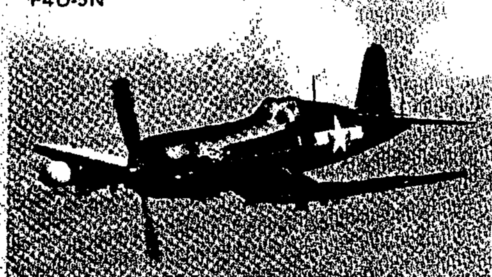
DECLASSIFIED

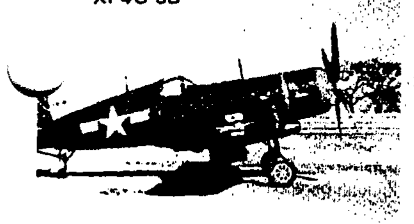
naval aircraft

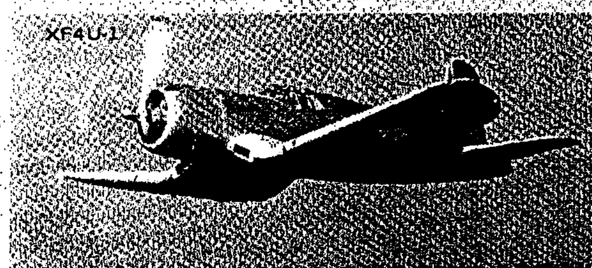
F4U Corsair

By Harold Andrews


F3A-1


F4U-5N


XF4U-3B


XF4U-1

On the occasion of the 75th Anniversary of Naval Aviation, it is notable that Vought *Corsairs* have been on board for more than two-thirds of the period.

First came the series of biplanes, starting in 1926. Before they were totally phased out, the XF4U-1 entered the scene in 1940. The inverted gull-wing *Corsairs* continued the tradition for a total of some 30 years when the last of the fighter-bomber *Corsairs* was retired. After a break, the A-7 *Corsair II* (the biplane's name was unofficial) picked up in 1965, continuing to the present, with more years to come.

So, it is appropriate to cover the first official *Corsair* on this anniversary year. Significantly, the first biplane *Corsairs* (O2Us), the F4Us and the A-7s have all played key roles in Navy and Marine Corps combat operations.

The story of the *Corsair* of WW II and Korean operations starts in 1938. The Navy was looking for a new carrier fighter with significant increases in performance over the Grumman F4F and Brewster F2A, then in the development/test stage. In the design competition a Vought proposal — designed around the new Pratt and Whitney 1,800-hp R-2800 Double Wasp engine — was awarded an experimental prototype contract.

The most unusual feature of Vought's design was its inverted gull wing, which allowed a shorter, lighter landing gear. This provided adequate ground clearance for the large-diameter propeller required to absorb the power of what was then the largest engine available for a fighter airplane.

First flown on May 29, 1940, the XF4U-1 had an armament of four guns, two synchronized to fire through the propeller disc, the other two outboard in the wings. It was the first single-engine fighter capable of over 400 mph.

As part of the U.S. military buildup which preceded *Pearl Harbor*, production of the F4U-1 was ordered. Based on European wartime experience, increased armament and gunfire protection were required, resulting in extensive redesign of the production *Corsairs*. A large self-sealing fuel tank was located over the wing in the fuselage, while three .50 machine guns were installed outboard of the prop arc in each wing. The fuselage fuel tank caused the cockpit to be moved aft, which resulted in the characteristic "long nose" of the *Corsair*. An unusual feature of the *Corsair* was the fabric covering of the outer wing panels aft of the main spar. The construction was otherwise typically all metal with fabric-covered control surfaces.

Design and construction of the initial production F4U-1s were well along when the U.S. entered WW II. To meet anticipated Navy/Marine needs, Goodyear and Brewster were also given contracts to produce *Corsairs* as the FG-1 and F3A-1, respectively, with Vought-Sikorsky retaining overall design responsibility.

June 1942 brought the first production F4U-1 flight, with testing, Navy trials and service introduction following. Early carrier trials revealed some problems with carrier landings, leading to a decision to operate *Corsairs* from land until satisfactory characteristics were achieved. Thus, the Marines became a major user, along with shore-based Navy squadrons.

While this problem was being tackled, other improvements were made in the -1 *Corsairs* and incorporated at all three production plants. The most obvious was a raised, three-panel canopy for improved visibility. At the same time, a dozen F4U-1s were being modified as F4U-2 night fighters with a radar nacelle on the right wing, outboard. Additional conversions were subsequently made and, in early 1944, these night fighters were the first *Corsairs* based on U.S. carriers. The F4U-1C, with four 20mm cannon in place of the six .50s, and the F4U and FG-1D, with additional store-carrying capability and water injection for the engine, followed. Brewster's *Corsair* production was cancelled before shifting to the -1D.

By the time the -1Ds were in service, the carrier landing problem had been solved. Changes to the main gear oleos and a taller tail wheel assembly led to full carrier use of the *Corsair*. A large number of -1 and -1D *Corsairs* were provided to the British Fleet Air Arm. Their wing tips ar- slightly clipped to clear the lower overhead on the Royal Navy carriers, where they were fully operational even before the landing gear fixes were installed. Much of Goodyear's later production was built as the -1A, for land-based use without folding wings and other carrier systems. New Zealand's RNZAF also flew -1s. As a fighter and fighter-bomber, the *Corsair* was one of the outstanding WW II combat aircraft.

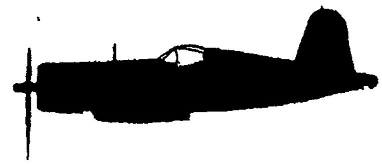
Attempts to increase the *Corsair's* performance at altitude led to the experimental turbo-supercharged XF4U-3. While a few FGs were modified late in the war to FG-3 configuration, they did not become operational. The next improved engine installation was the "C" series Double Wasp, first in experimental -4s and subsequently in full production at Vought. Goodyear was in the process of changing over when production there was terminated after VJ day. The improved performance justified continued production after the war, including cannon-armed -4Bs, night fighter -4Ns, search radar-equipped -4Es, and photographic -4Ps. Goodyear's ...pment of a much more powerful ...r, the F2G with the Pratt and Whitney R-4360 engine, was also closed out in the postwar years after 10 production aircraft had been built.

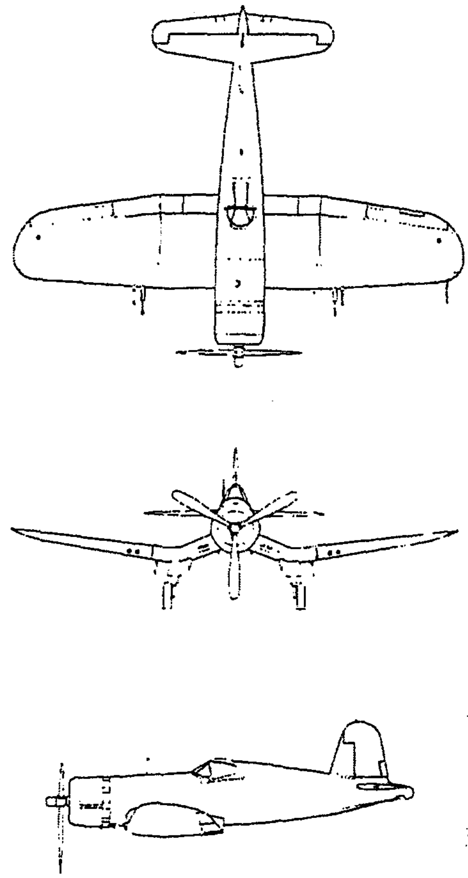
The new E series R-2800 developed by Pratt and Whitney led to the -5 *Corsair*, with further performance improvements. Replacing the -4 in production in 1947, it was the first "all-metal" *Corsair*, including all-metal outer wing panels. The FG-1Ds continued as mainstays of the Reserves, while the -5s gradually replaced the -4s in fleet squadrons. The -5N night fighters became major components of carrier air groups as the new jets took over the basic day fighter role. Some -5Ps were also built.

Production of the -5 series continued at Vought after its move to Dallas, and the Korean conflict brought the *Corsair* back once more into the forefront. F4U-4s returned in numbers to the carriers and winterized -5NL versions were built to operate better in frigid weather conditions. The Navy and Marines both very successfully employed the night fighter -5Ns and -5NLs. A low-altitude, heavily armored version of the -5 was built as the XF4U-6; production aircraft were redesignated AU-1s. Production of 110 completed the Navy acquisition of *Corsairs*, though the French F4U-7s were the last off the line. With the end of the Korean war in 1953, the *Corsairs* were rapidly released from operational squadrons, though they continued another few years in support roles.

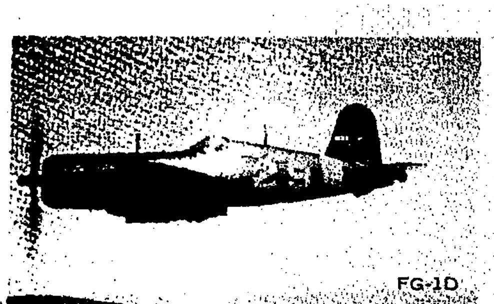
Furnished to several other countries, particularly Central and South America, as well as France, *Corsairs* continued in operational use and in intermittent combat for many more years. They also made their debut in air races soon after WW II, especially with the R-4360 engine, and established a winning record. With their unique wing configuration and outstanding performance, the more than 12,500 built are well commemorated by the few that can still be regularly seen flying at air shows and air races, and those in many museums. ■

F4U-1C

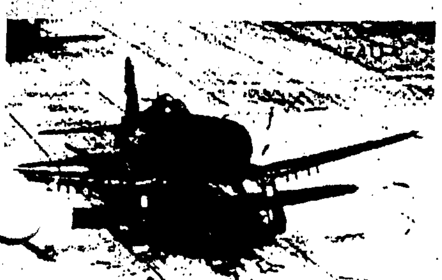




F4U-4

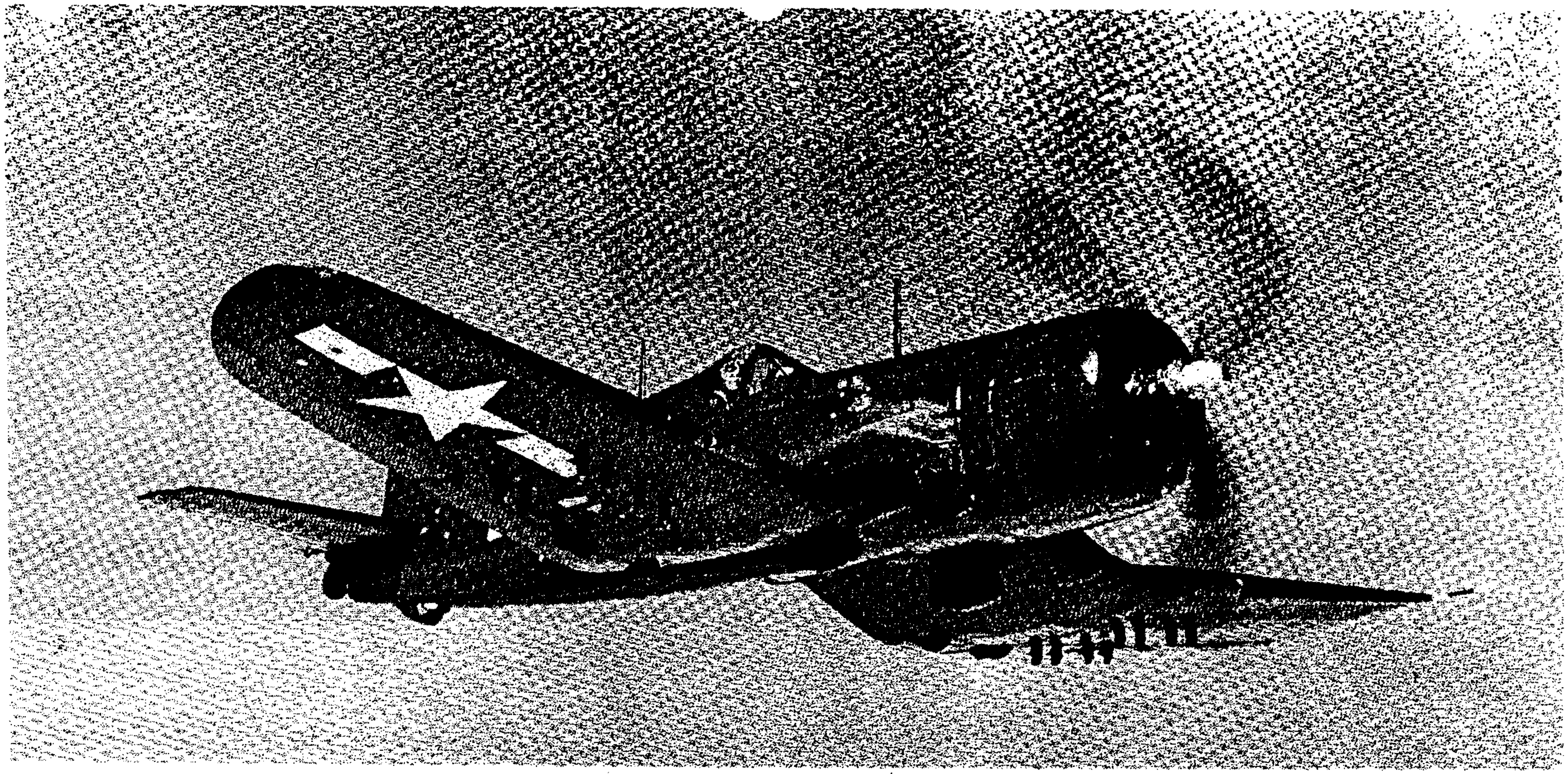


FG-1D



AU-1

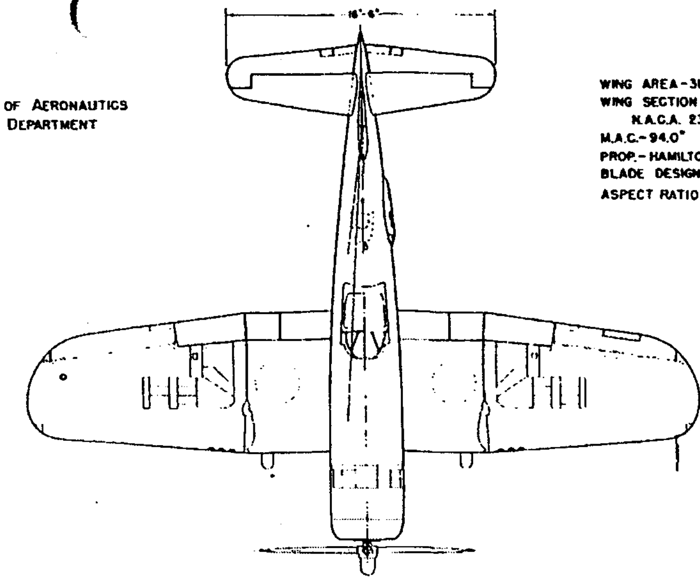
	F4U-1	F4U-5
Length	33'4"	34'6"
Height	14'11"	14'0"
Span	41'0"	41'0"
Gross weight	12,039 lbs.	12,902 lbs.
Engine		
P&W R-2800-8	2,000 hp	P&W R-2800-32W 2,300 hp
Performance		
Max. speed	407 mph	462 mph
Service ceiling	36,800'	43,500'
Range	1,515 mi.	1,036 mi.
Crew	One	One
Armament:	Six .50 machine guns and one 1,000-lb. bomb (by field mod).	Four 20mm cannon and up to two 1,600-lb. bombs plus eight 5" rockets.

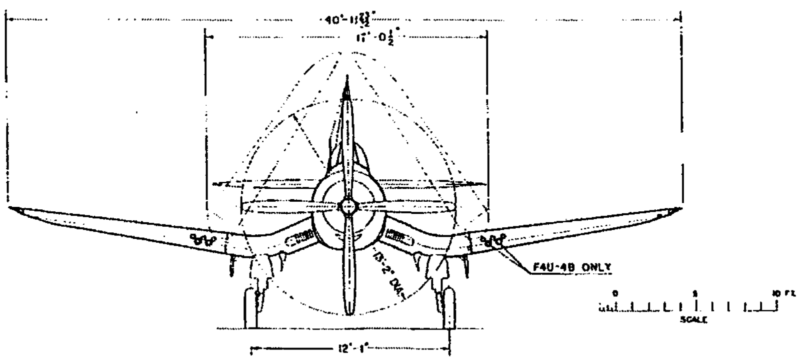


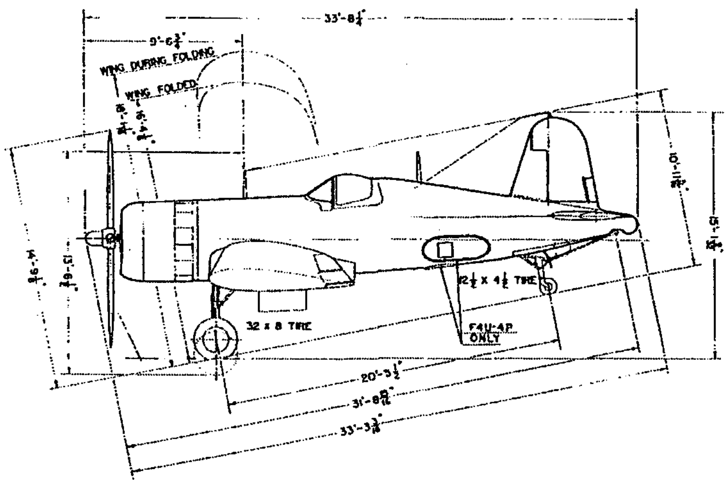
STANDARD AIRCRAFT CHARACTERISTICS
F4U-4 "CORSAIR"

BUREAU OF AERONAUTICS
NAVY DEPARTMENT

WING AREA-314 SQ. FT.
WING SECTION –
N.A.C.A. 23018-23009
M.A.C.-94.0"
PROP.-HAMILTON STD. C.S.
BLADE DESIGN NO. 6501A-0
ASPECT RATIO 5.4







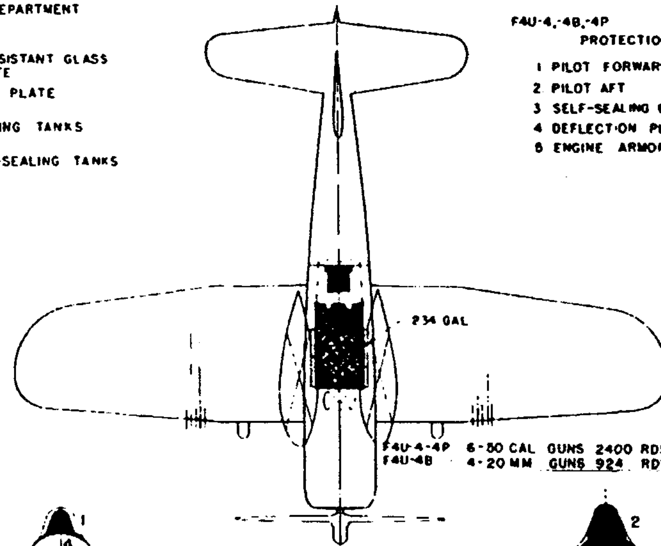
DESCRIPTIVE ARRANGEMENT

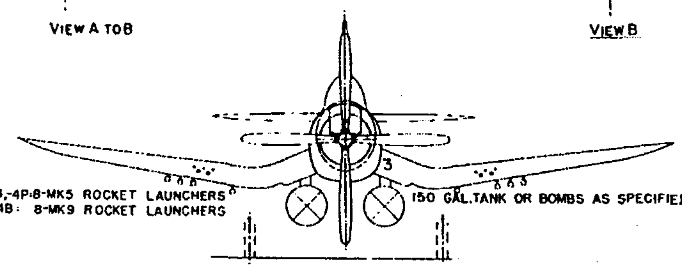
BUREAU OF AERONAUTICS
NAVY DEPARTMENT

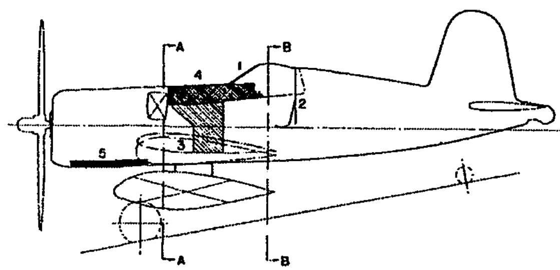
- ■ BULLET RESISTANT GLASS ARMOR PLATE
- ■ DEFLECTION PLATE
- ▨ SELF-SEALING TANKS
- ☒ NON SELF-SEALING TANKS

F4U-4,-4B,-4P
PROTECTION

1	PILOT FORWARD	36.6 LBS.
2	PILOT AFT	60.2 LBS.
3	SELF-SEALING CEELS	177 LBS
4	DEFLECTION PLATE	20 LBS
5	ENGINE ARMOR	175 LBS







ARMAMENT & TANKS

MISSION AND DESCRIPTION

This airplane is a conventionally powered, high performance, carrier or land based, general purpose fighter.

The primary mission is the destruction of enemy aircraft, airborne or grounded. This mission may be carried out on an offensive basis in which case the action would presumably be carried out over enemy held territory or on a defensive basis when interception of an incoming enemy attack becomes a necessity. A secondary mission of this type results from its flexibility in regard to ordnance carrying capabilities. Armed with bombs and/or rockets, within prescribed limits, it may be used to great advantage for destroying enemy ground installations.

The outstanding configuration characteristic of this low-wing monoplane is the inverted gull appearance of the wing coupled with great length of fuselage ahead of the cockpit canopy.

It is of conventional structure. The wing center section is a metal box-beam, with single-spar panels fabric covered aft of the spar. Wood ailerons, metal slotted flaps. Stabilizer of either conventional or metalite construction with fabric-covered movable surfaces. Quick-change power-plant with 13.5 gal. water tank. Folding wings.

DIMENSIONS

SPAN..................41'-0"
LENGTH................33'-8"
HEIGHT................14'-9"
WING AREA........314 sq. ft.
M.A.C....................94"
TREAD..................12'-1"

WEIGHTS

Loadings	Lbs.	L.F.
EMPTY	9167	
BASIC	9859	
DESIGN	10138	8.10
COMBAT	12405	7.25
MAX.T.O.	16160	5.60
MAX.LAND	15000	

All weights are actual.

FUEL AND OIL

Gals. - No. Tanks - Location
234.......1...Fuse.(protected)
300.......2...Wing (drop)
FUEL GRADE.....115/145
FUEL SPEC......AN-F-48

OIL

CAPACITY (Gals.).........23.5
SPEC..................AN-0-8
GRADE..............1100-1120

ELECTRONICS

TRANSMITTER.......RT-18/ARC-1
RECEIVER, LF......R-23A/ARC-5
RECEIVER, VHF......R-4A/ARR-A
IFF..............RT-22/APX-1

POWER PLANT

NO. & MODEL....(1) R-2800-18W
MFR..................P. & W.
SUPERCH......2 Stage, 2 Speed
PROP.GEAR RATIO..........20:9
PROP. MFR...........Ham. Std.
PROP.DES.NO...........6501A-0
NO.BL./DIA...........4/13'-2"

RATINGS

	Bhp.	@ Rpm.	@ Alt.
T.O.	2100	2800	S.L.
MIL.	2100	2800	1000'
	1900	2800	14000'
	1800	2800	23000'
NORMAL	1700	2600	7000'
	1630	2600	18000'
	1550	2600	26000'

SEE NOTE
SPEC NO. N-8082

ORDNANCE

GUNS

No.	Size	Location	Rds.
6	.50 Cal.	Wing	2400

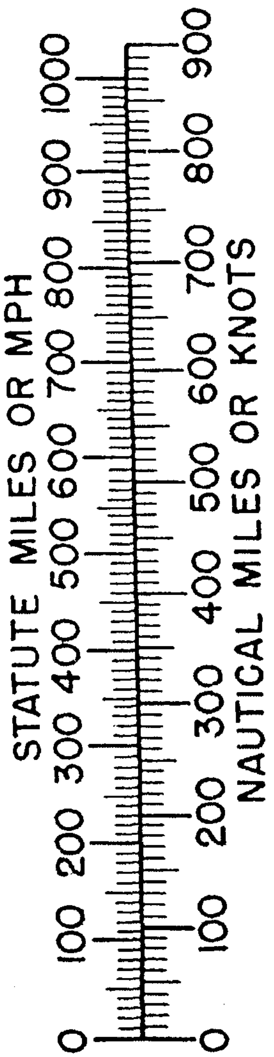
MK. 8-6 Illuminated Sight

BOMBS

Type	Size	Location	No.
Bomb	1000#	Wing	2
Bomb	500#	Wing	2
Bomb	250#	Wing	2

ROCKETS

HVAR	5"	Wing	8
on MK.5 Rocket Launcher			
A.R.	11.5"	Wing	2



PERFORMANCE SUMMARY

LOADING CONDITION		(1) Fighter 1-150 Gal. Tank External	(3) Rocket 2-11.75" AR 8-5" HVAR	(5) Escort 2-150 Gal. Tanks External	
TAKE-OFF WEIGHT	lbs	13597	16160	14658	
Fuel (fixed/drop)	lbs	1404/900	1404/	1404/1800	
Bombs	lbs				
	lbs				
Wing/Power Loading (A) lbs/sq.ft. lbs/	bhp	43.3/5.7	51.5/10.5	46.7/9.5	
Stall Speed--Power off	kn	81.0	88.3	84.1	
Stall Speed--Power off - No Fuel	kn	73.8	84.4	74.4	
Stall Speed--Power on	kn	66.9	73.0	69.5	
Maximum Speed/Alt (B)	kn/ft	347/31400	303/30600	326/31000	
Take-off Distance, deck -- calm	ft	790	1349	974	
Take-off Distance, deck 25 kn.	ft	377	708	480	
Take-off Distance, Airport	ft				
Rate of climb -- sea level (B)	ft/min	2510	1880	2320	
Service Ceiling (B)	ft	38400	34800	36700	
Time-to-climb 10000 ft. (B)	min	4.2	5.9	4.7	
Time-to-climb 20000 ft. (B)	min	8.8	13.1	10.0	
Combat Range/V av 15000 ft.	n.mi/kn	1005/185	360/182	1300/180	
Combat Radius/V av ft.	n.mi/kn	315/178	35/178	525/178	
LOADING CONDITION		(2) Combat	(4) Combat		
GROSS WEIGHT	lbs	12480	12480		
Engine power		Maximum	Normal		
Fuel	lbs	1404	1404		
Bombs/Tanks					
Max. speed at sea level	kn	325	280		
Max. speed /ACA ft.	kn	393/20500	372/31800		
Combat speed/Alt.	kn/ft	378/15000	320/15000		
Rate of climb SL	ft/min	4770	2910		
Ceiling for 500 fpm R/C	ft	38500	37100		
Time-to-climb/Alt.	min/ft	4.9/20000	7.5/20000		

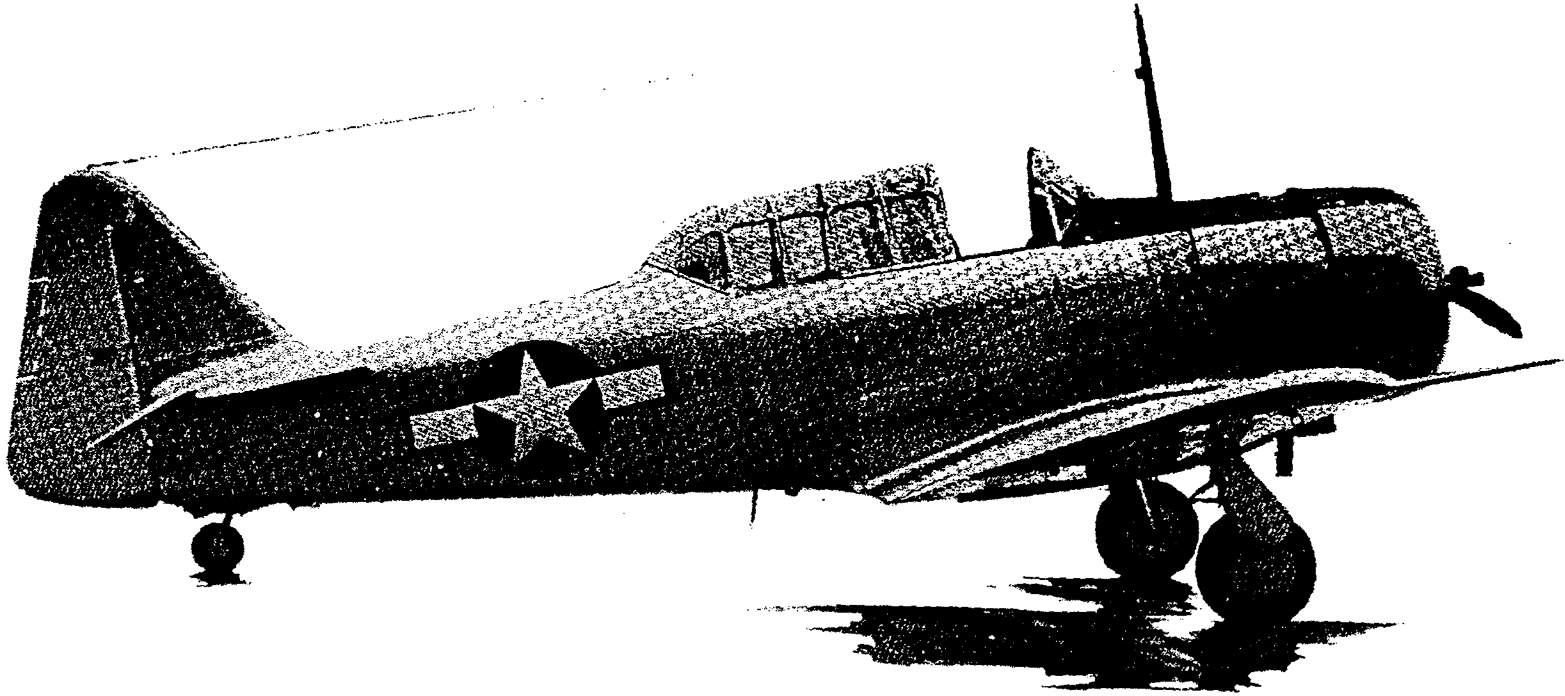
NOTES

(A) BHP at Maximum Critical Altitude

(B) Normal BHP

Performance is based on flight test of the F4U-4 airplane.
Range and radius are based on flight test fuel consumption data of the F4U-4 airplane increased by 5%.

Combat Condition: Two capped pylons aboard. Rocket launchers not aboard. Addition of 8 MK5-1 launchers decreases Vmax at S.L. of Condition (2) to 318 knots and Vmax/ACA to 384 knots/20400 ft.

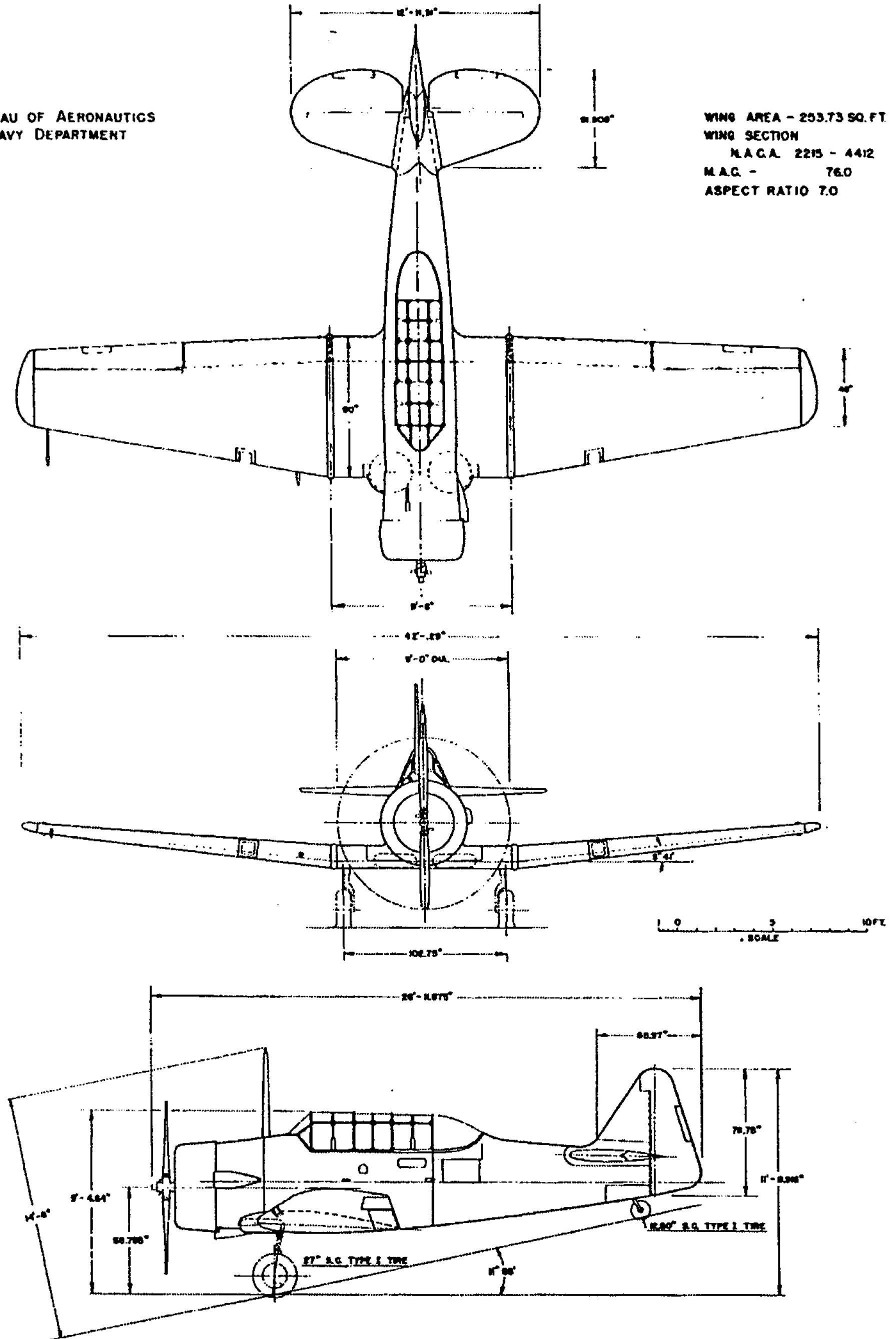


STANDARD AIRCRAFT CHARACTERISTICS

SNJ-4,-5,-6 "TEXAN"

BUREAU OF AERONAUTICS
NAVY DEPARTMENT

WING AREA - 253.73 SQ. FT.
WING SECTION
N.A.C.A. 2215 - 4412
M.A.C. - 76.0
ASPECT RATIO 7.0



DESCRIPTIVE ARRANGEMENT

MISSION AND DESCRIPTION

All-purpose trainer. Originally procured by Army Air Force for Navy (Navy version of AT-6) for intermediate and instrument flight training. Now used as primary and basic trainer and for pilot's flight proficiency.

Conventional design, two place tandem, low wing, all metal, single engine, land plane with retractable main landing gear. Manufactured by North American Aviation Corporation.

Wing structure is conventional, with a two-spar system. Split flap is hydraulically actuated. The fuselage is of chrome-molybdenum tube truss to the rear of the aft cockpit, with a wood or metal semi-monocoque structure aft of that. Later aircraft have wood stabilizers.

DIMENSIONS

SPAN..................42'-0"
LENGTH................29'-0"
HEIGHT................14'-8"
WING AREA......253.7 sq. ft.
M.A.C.....................76"
TREAD.................8'-7"

WEIGHTS

(Load	Lbs.	LF)
EMPTY	4143 (-4)	
	4082 (-5)	
	4050 (-6)	
BASIC	4201 (-4)	
	4140 (-5)	
	4108 (-6)	
DESIGN	5600	5.22
MAX.T.O.	5500	5.30
MAX.LAND.	5500	

All weights are actual.

FUEL AND OIL

Gals.	No. tanks	Location
111	2	Wing

FUEL GRADE...91/96
FUEL SPEC....AN-F-48

OIL

CAPACITY (gal)...........10
SPEC.................AN-O-8
GRADE............1100-1120

ELECTRONICS

(12 Volt System)(SNJ-4)
Command...........SCR-AL-183

(24 Volt System)(SNJ-5,-6)
Command...........SCR-274-()
Marker beacon.........RC-34B
or RC-193-()

POWER PLANT

NO. & MODEL...(1) R-1340-AN-1
MFR......................P&W
SUPERCH.......1 Stage, 1 Speed
PROP.GEAR RATIO.........D.D.
PROP MFR...........Ham. Std.
PROP DESIGN NO...........6101
NO.BL./DIA...........2/9'-0"

RATINGS

	Bhp.	@Rpm.	@Alt.
T.O.	600	2250	SL
NORMAL	550	2200	5000'

DATA FROM ENGINE SPEC.
AN-1051

ORDNANCE

Provisions for:

GUNS

No.	Size	Type	Rds.
1	.30 cal.	cowl	200
1	.30 cal.	rear	500
1	.30 cal.	wing	200

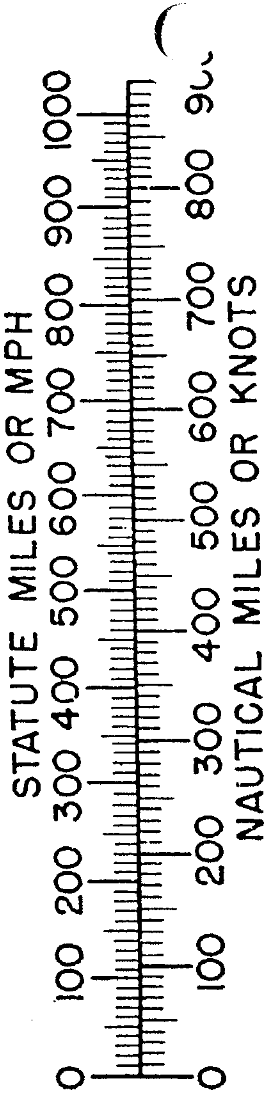
K-3 oblique & vert. camera

Gun camera, in wing

N-3 gun sight

BOMBS

No.	Size	Location
10	20#	wing
4	100#	



PERFORMANCE SUMMARY

LOADING CONDITION		TRAINER			
TAKE-OFF WEIGHT		5282			
Fuel	lbs	666			
Bombs	lbs				
	lbs				
Wing/Power Loading (A) lbs/sq.ft. lbs/	bhp	20.8/9.6			
Stall Speed--Power off	kn	55.7			
Stall Speed--Power off - No Fuel	kn	52.1			
Stall Speed--Power on	kn	50.9			
Maximum Speed/Alt (B)	kn/ft	178/5100			
Take-off Distance, deck -- calm	ft	599			
Take-off Distance, deck kn.	ft				
Take-off Distance, Airport	ft	1180			
Rate of climb -- sea level (B)	ft/min	1400			
Service Ceiling (B)	ft	22400			
Time-to-climb 10000 ft. (B)	min	8.0			
Time-to-climb 20000 ft. (B)	min	25.7			
Combat Range/V av 1500 ft.	n.mi/kn	560/97			
Combat Radius/V av ft.	n.mi/kn				
LOADING CONDITION					
GROSS WEIGHT	lbs				
Engine power					
Fuel	lbs				
Bombs/Tanks					
Max. speed at sea level	kn				
Max. speed ft.	kn				
Combat speed/Alt.	kn/ft				
Rate of climb SL	ft/min				
Ceiling for 500 fpm R/C	ft				
Time-to-climb/Alt.	min/ft				

NOTES

(A) BHP at Maximum Critical Altitude
(B) Normal BHP

Performance is based on flight test. Range is based on engine specification fuel consumption data increased by 5%.

This airplane is not suited for dive bombing training due to speed limitations

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NAVAER-1519A-(Rev. 9-44)

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AIRPLANE CHARACTERISTICS & PERFORMANCE

BUREAU OF AERONAUTICS, NAVY DEPT.

COLUMN NUMBER	1	2	3	4
LOADING CONDITION	COMBAT *	COMBAT *	COMBAT *	FIGHTER One 150 Gal. Fuselage Tank External
GROSS WEIGHT — LBS.	21476	21476	21476	22567
EMPTY WEIGHT -Calculated- LBS.	16400			
FUEL / OIL — GALS.	375/21	375/21	375/21	525/30
FIXED GUNS/AMMUNITION	4 - 20mm/800 rds			
FLEXIBLE GUNS/AMMUNITION	None			
ENGINE POWER USED FOR PERFORMANCE	COMBAT	MILITARY	NORMAL	NORMAL
WING LOADING — LBS/SQ.FT.	47.2	47.2	47.2	49.6
POWER LOADING ① — LBS./BHP.	5.8	6.3	7.1	7.5
V-MAX. SEA LEVEL — MPH.	359	351	327	319
V-MAX./CRITICAL ALT. — MPH./FT.	423/21900	416/22900	400/23100	390/23000
V-STALL GROSS WEIGHT ② — MPH.	90.9	90.9	90.9	93.0
V-STALL WITHOUT FUEL ② — MPH.	86.0	86.0	86.0	86.4
TIME-TO-CLIMB -10000 FT- MIN.	2.2	2.5	3.2	3.4
TIME-TO-CLIMB -20000 FT- MIN.	5.2	5.7	6.9	7.5
SERVICE CEILING — FT.	40800	40200	39200	38400
TAKE-OFF DISTANCE -CALM- FT.	637	637	637	709
TAKE-OFF DISTANCE -15 KN.- FT.	423	423	423	477
TAKE-OFF DISTANCE -25 KN.- FT.	304	304	304	345
TAKE-OFF DISTANCE -50 FT. OBST. FT.				
TAKE-OFF TIME — SECONDS				
...TE OF CLIMB -SL- FT./MIN.	4580	4200	3260	3030
...AX. RANGE / V-AV. ③ ST. MI./MPH.				
RANGE / V-AV. -60%NSP-③- ST. MI./MPH.			960/170	1260/179
SEARCH RADIUS / V-AV. -20%R- NMI./KN.				
A.S.W. RADIUS / V-AV. -20%R- NMI./KN.				
SCOUT RADIUS — N MI.				
COMBAT RADIUS (F-1) N MI.			15	180

ENGINE / PROP. GEAR RATIO: 2 P & W R-2800-34W (.45)

ENGINE RATING — BHP/RPM/ALT.

COMBAT	MILITARY	NORMAL	TAKE-OFF
2380/2800/S.L.			
2400/2800/1000'	2100/2800/SL-3400'	1700/2600/SL-8500'	2100/2800/SL
1790/2800/9500'	1700/2800/9500'-16600'	1500/2600/11700-18300	
1850/2800/15500			

TANKAGE IN GALLONS		OIL	FUEL
FIXED	PROTECTED	42	375
FIXED	UNPROTECTED		
FIXED	TOTAL-FIXED INTERNAL	42	375
AUX.	DROPPABLE Wings - 2 @ 150		300
AUX.	DROPPABLE Fuse. - 1 @ 300 (alternate - 1 @ 150)		300
	TOTAL	42	975

STATUTE MILES USED-EXCEPT-RADIUS IS GIVEN IN NAUTICAL MILES & KNOTS

① BHP AT MAX. CRIT. ALT.

② STALL-WITH POWER

③ AT 1500' ALTITUDE (Manual Lean)

OFFENSIVE ARMAMENT

FUSELAGE - External
- Bombs - 1-2000# or 1-1600#
- Torpedoes - 1 MK-13-3
- Mines - 1-1860# or 1-1600#
- Rockets - 1-11.75" A.R.

WINGS - External
- Bombs - 2-1000#, 2-500#, 2-250# or 2-100#
- Depth Bombs - 2-650# or 2-325#
- Mines - 2-1000#
- Rockets - 2 - 11.75" A.R.

WINGS - Outer Panel - MK-9 Rocket Launcher
- Rockets - 8-5" HVAR or AR

DATE 1 MARCH 1946 [redacted] [redacted]

MODEL-F7F-3N