

SOUTHERN PACIFIC COMPANY

EXHAUST NOZZLE AND STACK HEIGHT TESTS ENGINE 4401

**SACRAMENTO LOCOMOTIVE
STANDING TEST PLANT**

**San Francisco, Calif.
April 28, 1948.**

Report No. ST-2

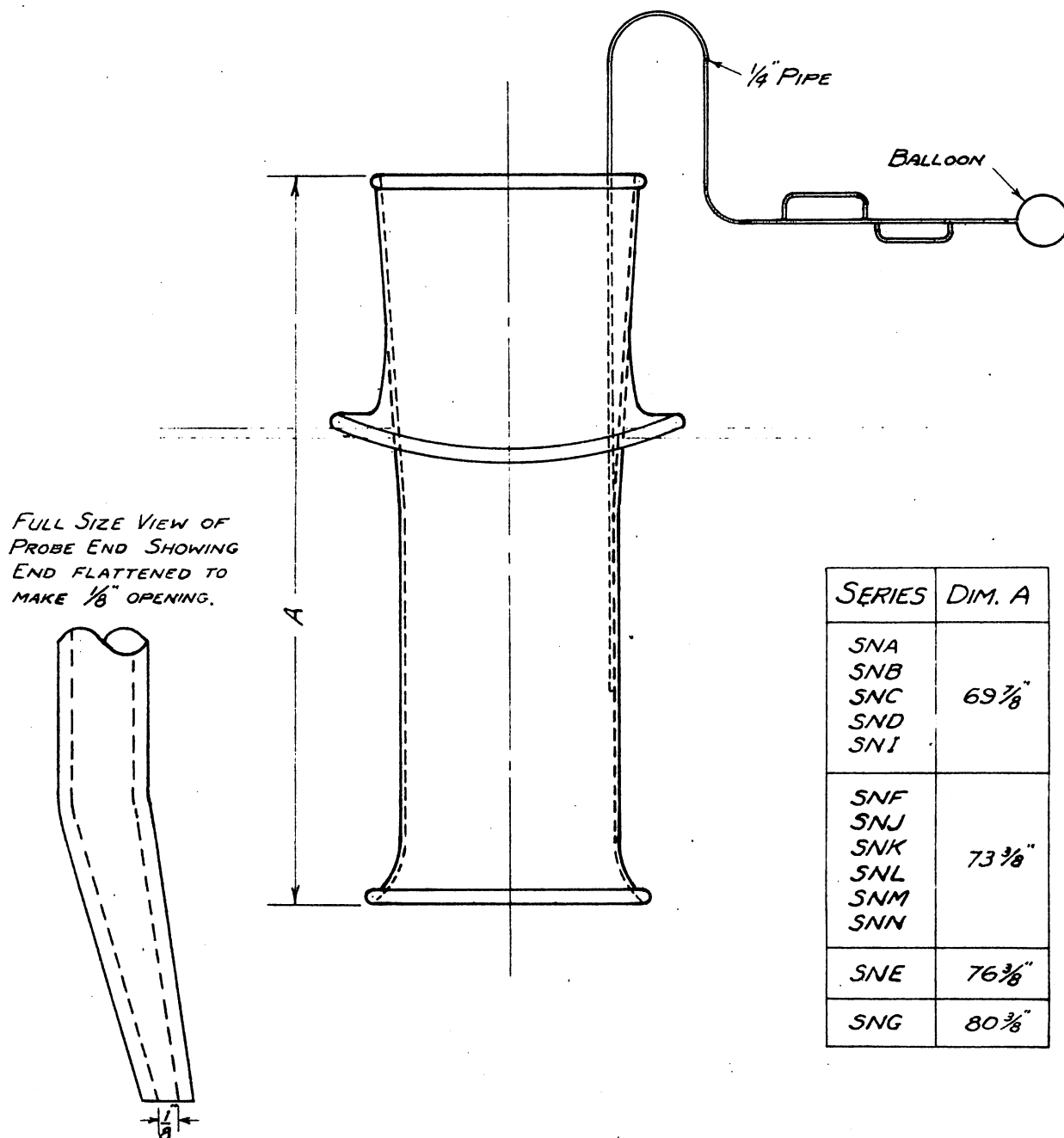
EXHAUST NOZZLE AND STACK TESTS - ENGINE 4401

DESIGNATION OF TESTS		CONDITIONS OF TESTS		
SERIES	NOZZLE DIA.	CROSS SPLIT		STACK HEIGHT: ABOVE NOZZLE:
		TYPE	SIZE	
SNA (Present Standard)	8"	SP Std.	3/4" Square	13 1/2"
SNB	8"	T&NO Std.	3/4" Wide	13 1/2"
SNC	8"	SP Std.	1/2" Square	13 1/2"
SND	8"	Pyramid Shaped Basket Bridge	1/2" Square	13 1/2"
SNE	8"	-do-	1/2" Square	7"
SNF	8"	-do-	1/2" Square	10"
SNG(No Netting)	8"	-do-	1/2" Square	3"
SNH	8"	None	None	13 1/2"
SNI	7.087"*	None	None	13 1/2"
SNJ	8"	SP Std.	1/2" Square	10"(X)
SNK	8"	T&NO Std.	3/4" Wide	10"(X)
SNL	8 1/2"	SP Std.	1/2" Square	10"(X)
SNM	8 1/2"	T&NO Std.	3/4" Wide	10"(X)
SNN	7.44"	Pyramid Shaped Basket Bridge	1/2" Square	10"(X)

* = Diameter based on area equivalent to 8" diameter nozzle with 1/2" square SP Standard cross split.

(X)= Optimum height based on results of previous work.

INDEX OF TESTS



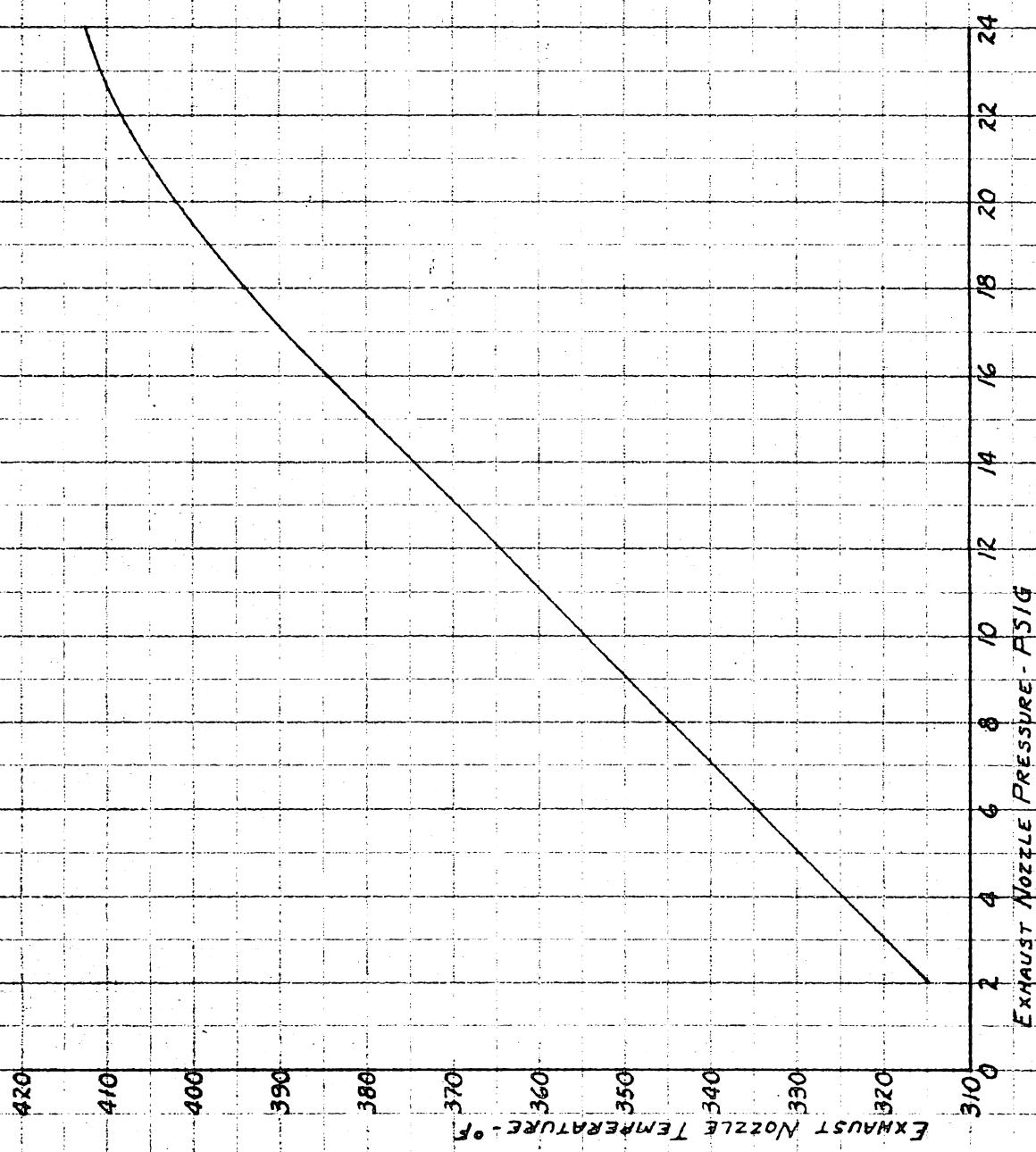
METHOD OF DETERMINING IMPINGEMENT POINT OF EXHAUST STEAM JET IN STACK

STANDING TEST

ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948



EXHAUST NOZZLE TEMPERATURE VS EXHAUST NOZZLE PRESSURE

STANDING TEST ENGINE 2401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-2

SUMMARY OF DATA USED IN PLOTTING CURVES

Stack and Nozzle Arrangements	Exhaust Nozzle Pressure	Firing Rate - Lbs. Oil Per Hour	Water To FWH-Lbs. Per Hour	Water To Boiler - Lbs. Per Hour	Boiler Efficiency Less FWH	Boiler Efficiency Incl. FWH	Fire-box Draft-Inches Water	Smoke-box Draft-Inches Water	Temperature Steam To Cylinders-OF.	Temperature Exhaust Steam OF.	Temperature Smoke-box Gases-OF.	Smokebox Gas Composition			*Lbs. Air Per Lb. Fuel	Air Flow Lbs. Per Hour	Excess Air - %	Stack Impingement Inches From Top of Stack	
	PSIG											CO2-%	O2-%	CO-%				Side	Back
Series SNA - 8" Dia. Nozzle, 3/4" Square Cross Split, Stack 13 1/2" Above Nozzle	5.2	3079	32545	35951	74.0	83.9	7.1	10.4	636	332	520	8.8	8.8	0.0	24.78	76285	67.9	-	-
	8.0	3679	38865	43273	75.2	85.4	9.9	14.6	660	345	536	9.4	8.9	0.0	23.85	87737	70.8	-	-
	11.7	4411	47026	52626	76.5	87.6	13.6	20.2	689	364	555	8.8	9.2	0.0	25.07	110584	74.4	-	-
	17.9	5540	58131	65390	75.5	87.5	18.1	27.6	712	397	574	9.4	8.2	0.0	23.39	129597	60.9	-	-
	17.7	5473	57421	64714	75.9	87.9	18.6	28.0	716	394	573	9.8	7.7	0.0	22.50	123115	55.0	-	-
	15.4	5036	53215	59697	76.1	87.8	16.8	25.2	708	381	570	-	-	-	-	-	-	-	-
Series SNB - 8" Dia. Nozzle. T&NO Cross Split. Stack 13 1/2" Above Nozzle.	17.9	6032	64053	71991	76.4	88.6	15.1	24.2	713	392	582	11.4	5.2	0.0	19.08	115097	29.5	35	29
	13.2	5201	55931	62488	77.1	88.6	12.7	20.0	698	368	568	10.6	6.4	0.0	20.76	107957	41.5	41	35
	8.6	4140	45104	50088	77.5	88.1	9.5	14.6	668	346	545	10.1	6.8	0.0	21.59	89391	45.2	43	39
	5.0	3192	35807	39297	78.0	88.1	6.9	10.0	627	328	515	10.3	6.8	0.0	21.33	68085	45.4	43	35
Series SNC - 8" Dia. Nozzle, 1/2" Square Cross Split, Stack 13 1/2" Above Nozzle.	8.3	4371	47025	52333	77.2	87.9	9.5	14.7	686	347	550	10.4	6.4	0.0	21.01	91817	41.4	41	31
	13.1	5360	57197	63767	76.8	88.2	13.4	20.7	711	368	565	10.7	6.4	0.0	20.63	110598	41.6	34	19
	17.1	6268	65821	73837	75.7	87.8	15.4	24.3	720	395	584	11.8	5.0	0.0	18.82	117989	29.6	34	19
Series SND - 8" Dia. Nozzle, 1/2" Basket Bridge Cross Split, Stack 13 1/2" Above Nozzle.	7.8	5114	55409	61543	77.6	88.3	9.9	15.3	683	342	560	12.6	4.0	0.0	17.71	90559	22.3	42	35
	7.9	5066	56048	61990	78.6	89.3	9.7	15.2	682	343	557	12.3	3.3	0.1	17.66	89460	17.2	42	35
	12.1	6204	66489	73620	76.8	87.9	13.5	21.5	710	364	587	12.5	3.3	0.1	17.48	108434	17.2	43	38
	9.8	5603	60743	67033	77.5	88.2	11.3	18.0	699	352	577	12.5	3.2	0.1	17.45	97767	16.6	43	29
	6.3	4435	49609	54785	79.4	89.9	8.2	12.7	665	335	548	12.2	3.9	0.1	17.94	79551	21.2	41	30
Series SNE - 8" Dia. Nozzle, 1/2" Basket Bridge Cross Split, Stack 7" Above Nozzle.	12.0	6288	67314	74703	76.5	87.7	13.0	20.7	703	366	592	12.5	3.4	0.2	17.40	109399	17.6	37	32
	9.7	5551	60593	67495	78.2	89.2	10.9	17.2	689	351	570	12.4	3.8	0.1	17.72	98358	20.5	37	32
	6.2	4531	50048	55355	78.3	88.7	8.4	12.5	659	336	544	11.7	4.2	0.0	18.64	84471	23.5	30	19
	4.6	3838	44168	48535	80.7	90.9	7.5	10.6	636	329	526	12.5	3.4	0.0	17.62	67618	18.2	-	-
	7.9	4997	55249	60961	78.6	89.3	9.9	15.0	679	348	565	11.8	2.8	0.0	18.08	90346	14.2	34	29
Series SNF - 8" Dia. Nozzle, 1/2" Basket Bridge Cross Split, Stack 10" Above Nozzle.	12.0	6276	67439	74959	77.1	88.5	12.7	20.7	710	368	581	12.6	3.4	0.0	17.53	109999	18.2	42	32
	9.9	5637	61141	67776	77.5	88.5	10.9	17.5	695	356	570	12.4	3.7	0.1	17.69	99707	19.9	40	31
	8.0	4971	55131	61060	78.8	89.7	9.3	14.7	674	345	557	12.2	4.0	0.0	18.09	89901	22.2	39	29
	6.4	4445	50317	55538	80.0	90.5	8.6	13.0	657	338	539	12.3	4.1	0.0	18.02	80103	22.9	35	26
	4.8	3795	43551	47773	80.2	90.3	7.2	10.4	632	330	518	12.2	4.2	0.0	18.15	68879	23.6	33	23
Series SNG - 8" Dia. Nozzle, 1/2" Basket Bridge Cross Split, Stack 3" Above Nozzle.	12.0	6369	67383	75025	75.9	87.1	12.3	19.9	701	366	587	12.7	3.4	0.0	17.44	111056	18.2	43	31
	9.6	5636	60297	66879	76.6	87.4	10.6	16.9	694	353	578	12.3	4.0	0.0	17.99	101386	22.2	41	29
	7.9	5053	55843	61719	78.5	89.2	9.6	14.9	674	345	558	12.1	4.0	0.0	18.18	91869	22.2	38	27
	6.3	4452	49925	55218	79.3	89.8	8.5	12.6	652	337	537	12.1	4.3	0.0	18.28	81384	24.3	35	22
	4.6	3803	43385	47685	79.8	89.9	7.2	10.4	630	328	520	12.1	4.4	0.0	18.31	69644	25.1	34	19

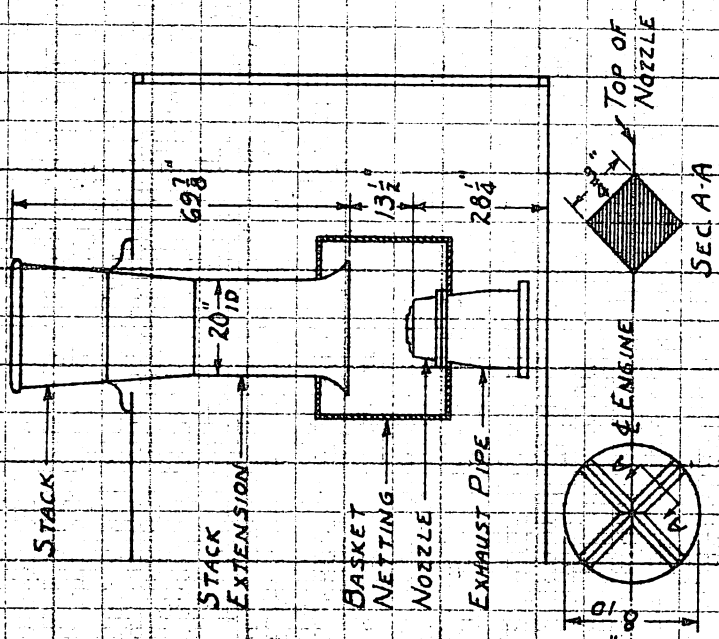
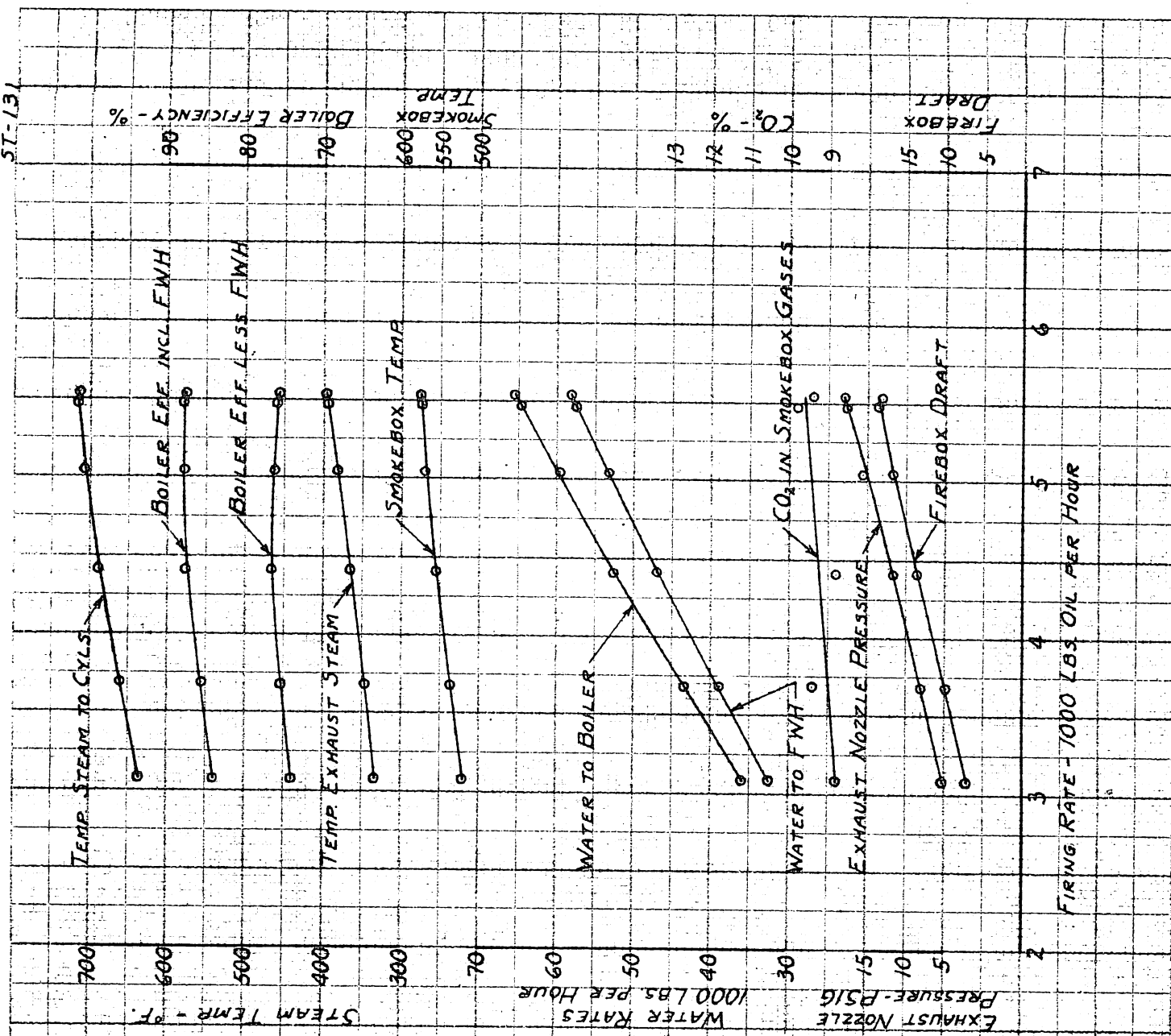
SUMMARY OF DATA USED IN PLOTTING CURVES

Stack and Nozzle Arrangements	Exhaust Nozzle Pressure PSIG	Firing Rate - Lbs. Oil Per Hour	Water To FWH-Lbs. Per Hour	Water To Boiler - Lbs. Per Hour	Boiler Efficiency Less FWH	Boiler Efficiency Incl. FWH	Fire-box Draft Inches Water	Smoke-box Draft Inches Water	Temperature Steam To Cylinders-OF.	Temperature Exhaust Steam OF.	Temperature Smoke-box Gases-OF.	Smokebox Gas Composition			*Lbs. Air Per Lb. Fuel	Air Flow Lbs. Per Hour	Excess Air - %	Stack Impingement Inches From Top of Stack	
												CO2-%	O2-%	CO-%				Side	Back
Series SNI - 7.087"	8.5	4046	45615	50645	78.9	90.1	7.5	10.9	638	346	527	12.7	3.3	0.0	17.41	70433	17.6	†	†
Dia. Nozzle, No	10.6	4491	50309	56060	78.7	90.3	7.7	11.7	650	357	539	12.9	3.3	0.0	17.23	77384	17.6	†	†
Cross Split, Stack	6.8	3600	41104	45425	79.6	90.2	6.6	9.4	623	340	515	12.6	3.8	0.0	17.65	63529	20.9	†	†
13½" Above Nozzle	13.1	5114	56258	62584	76.8	88.4	8.9	13.4	648	367	546	13.5	1.8	0.4	15.96	81619	7.8	†	†
Series SNJ - 8" Dia.	4.9	3343	36928	40803	77.6	87.7	7.0	10.2	632	330	523	10.5	6.8	0.0	21.07	70444	45.5	29	32
Nozzle. 1/2" Square	8.2	4333	47232	52809	78.0	88.9	9.5	14.7	669	349	551	10.5	6.7	0.0	21.02	91097	44.5	32	35
Cross Split, Stack 10"	13.0	5313	57164	64137	77.4	89.0	13.0	20.5	696	370	571	10.8	6.6	0.0	20.60	109464	43.7	32	32
Above Nozzle.	17.5	6204	64989	73191	75.3	87.5	15.9	25.2	713	395	580	11.6	5.5	0.0	19.10	118465	32.9	-	-
Series SNK - 8" Dia.	17.8	6027	64241	72085	76.5	88.7	14.8	23.5	709	393	580	11.4	5.3	0.0	19.36	116689	31.9	31	31
Nozzle, T&NO Cross	13.2	5179	55880	62417	77.3	88.7	12.5	19.5	693	370	572	10.9	6.1	0.0	20.26	104916	38.8	34	34
Split, Stack 10"	8.5	4184	45727	50821	77.7	88.4	9.4	14.4	663	347	543	10.3	6.8	0.0	21.33	89245	37.3	37	37
Above Nozzle.	5.1	3279	36544	40186	77.8	87.8	6.8	9.9	626	332	515	10.2	7.0	0.0	21.56	70705	47.4	42	40
Series SNL - 8½" Dia.	4.7	3639	40097	43977	77.2	87.0	7.4	10.7	633	327	520	11.5	5.6	0.0	19.37	70484	34.6	29	38
Nozzle, 1/2" Square	8.0	4693	51027	56913	77.8	88.6	9.8	15.2	671	347	549	11.3	5.8	0.0	19.67	92311	37.5	30	39
Cross Split, Stack 10"	11.9	5577	60316	67511	77.9	89.2	12.5	19.7	694	368	568	11.9	5.2	0.0	18.79	104809	32.5	29	37
Above Nozzle.	13.8	5964	64395	71847	77.4	89.1	13.4	21.5	702	375	580	12.4	4.6	0.0	18.09	107871	26.7	29	33
Series SNM - 8½" Dia.	8.1	4460	48604	53926	77.2	87.9	10.0	15.3	670	347	547	11.0	6.4	0.0	20.27	90409	41.8	43	33
Nozzle, T&NO Cross	12.9	5488	59530	66484	77.5	89.1	13.3	20.9	698	370	566	11.5	5.8	0.0	19.45	106731	36.4	40	33
Split, Stack 10"	14.9	5848	63114	70492	77.1	88.9	14.5	22.9	706	381	577	11.8	5.4	0.0	18.97	110942	33.0	40	30
Above Nozzle.	4.9	3435	38709	42404	78.3	88.3	7.4	10.6	631	329	521	10.8	6.6	0.0	20.60	70771	43.7	37	37
Series SNN - 7.44"	15.6	5909	63851	71653	77.2	89.4	11.7	18.7	690	382	561	12.6	4.1	0.1	17.63	104152	22.7	15	19
Dia. Nozzle, 1/2"	12.9	5293	57716	64528	77.7	89.4	10.7	16.6	680	371	556	12.5	4.3	0.0	17.90	94718	24.5	15	15
Basket Bridge Cross	8.2	4120	46259	51427	79.1	90.1	8.6	12.3	643	348	523	12.7	4.0	0.2	17.39	71663	21.7	16	10
Split, Stack 10"	5.0	3157	36174	39833	79.4	89.7	6.2	8.6	607	329	504	12.4	4.1	0.0	17.93	56592	23.0	33	8

* Calculated from Formula - Lbs. Air per Lb. Fuel = $\frac{18.3 N_2}{0.525 N_2 + 5CO + 4CO_2 - 2O_2}$

† Steam jet did not fill stack.

57-131



SERIES SNA
8" DIA. NOZZLE WITH
4" CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO
APRIL 1, 1948

FIG. 2-5

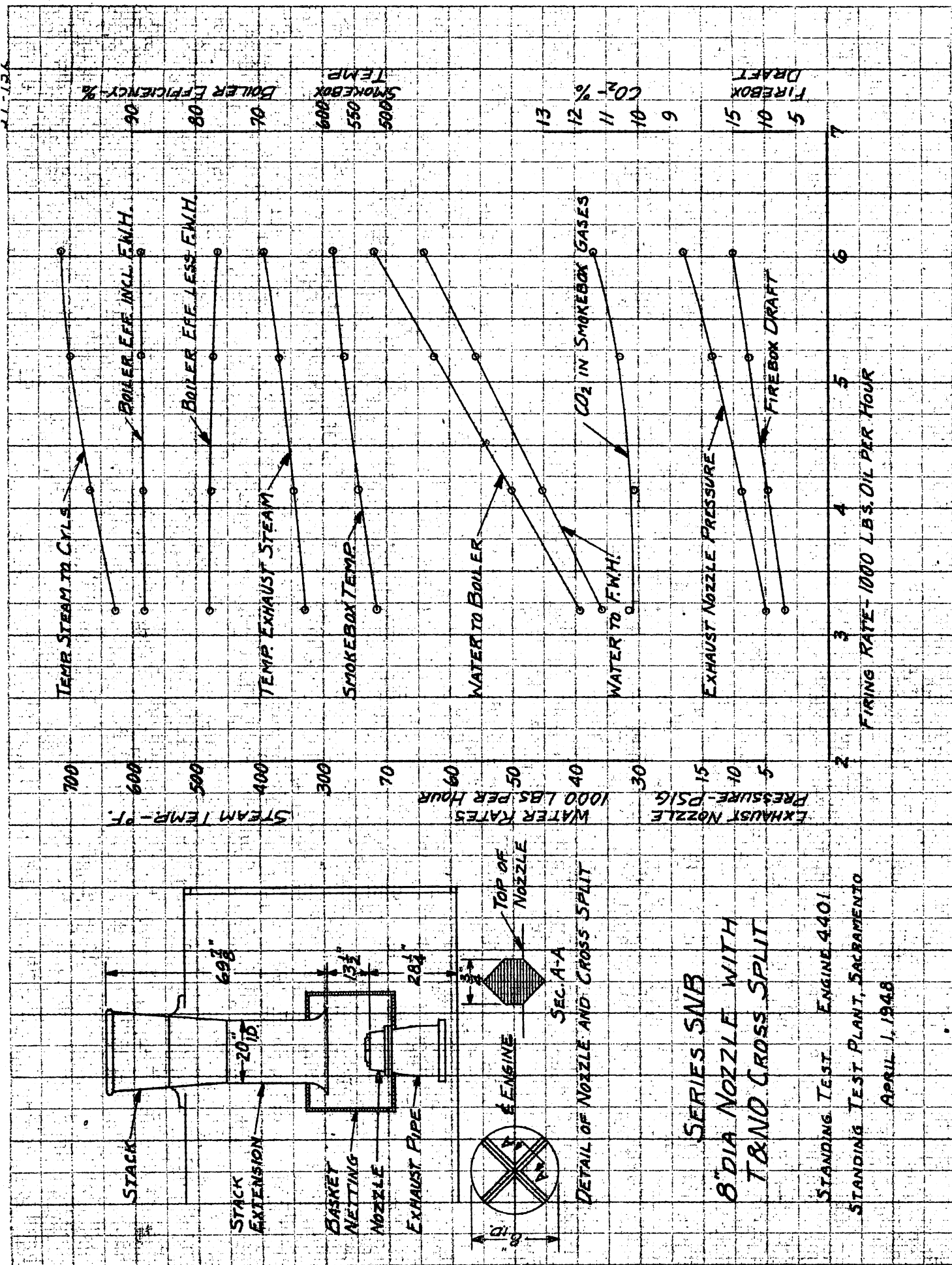
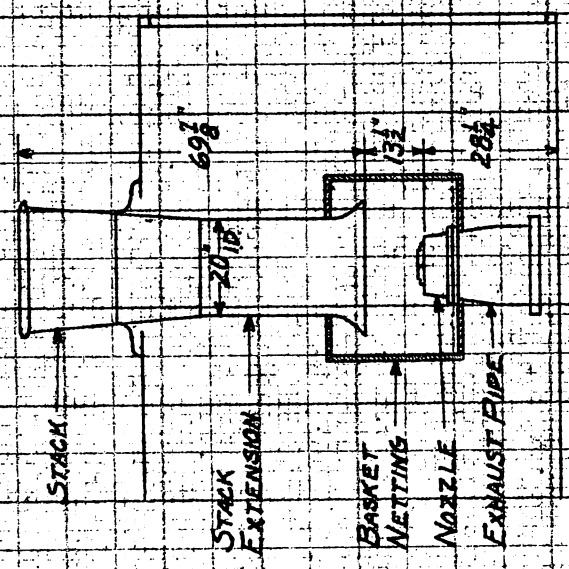


FIG. 2-6



DETAIL OF NOZZLE AND CROSS SPLIT

SERIES SNC
8" DIA NOZZLE WITH
1/2" CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT SACRAMENTO
APRIL 1, 1948

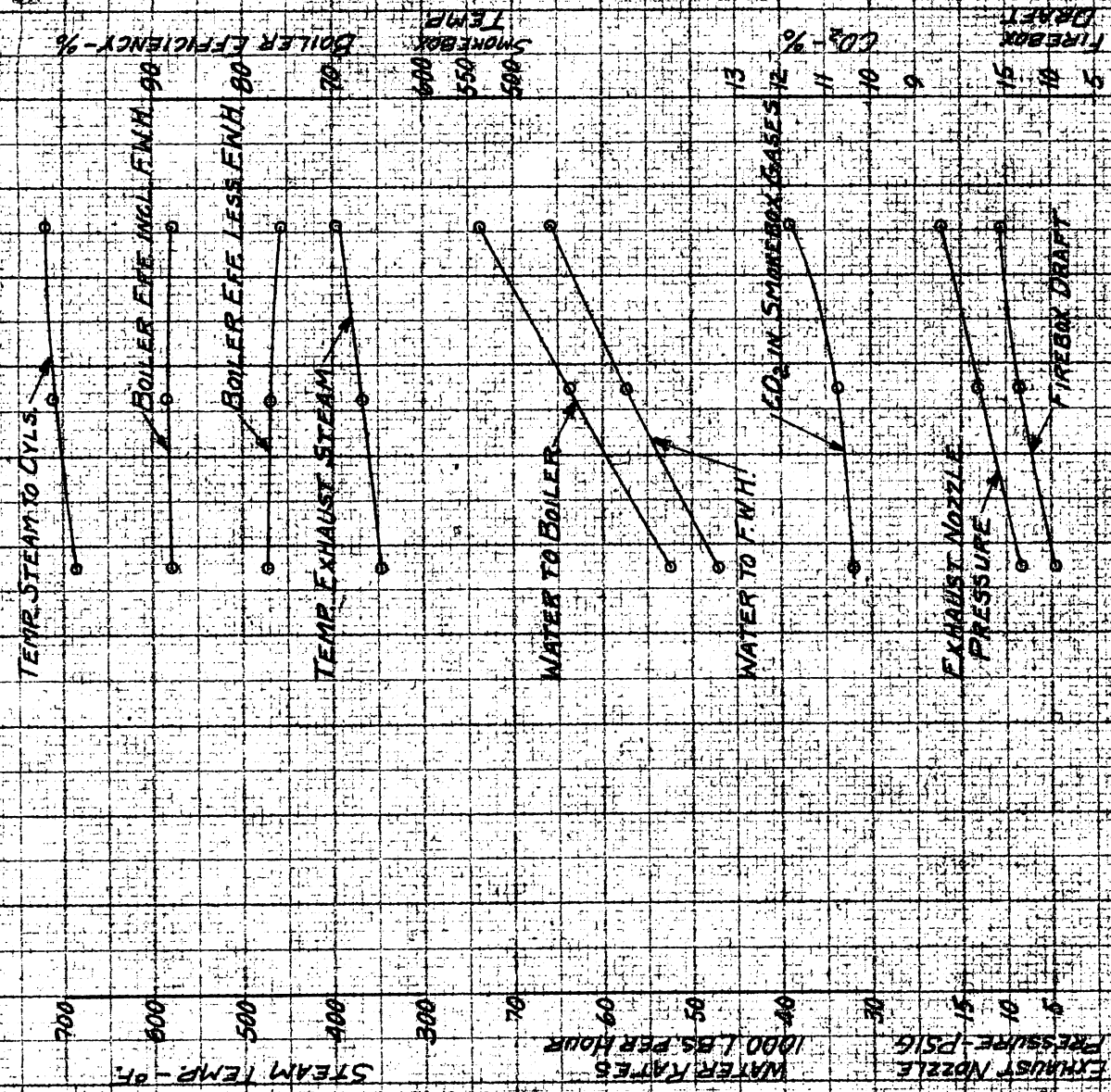
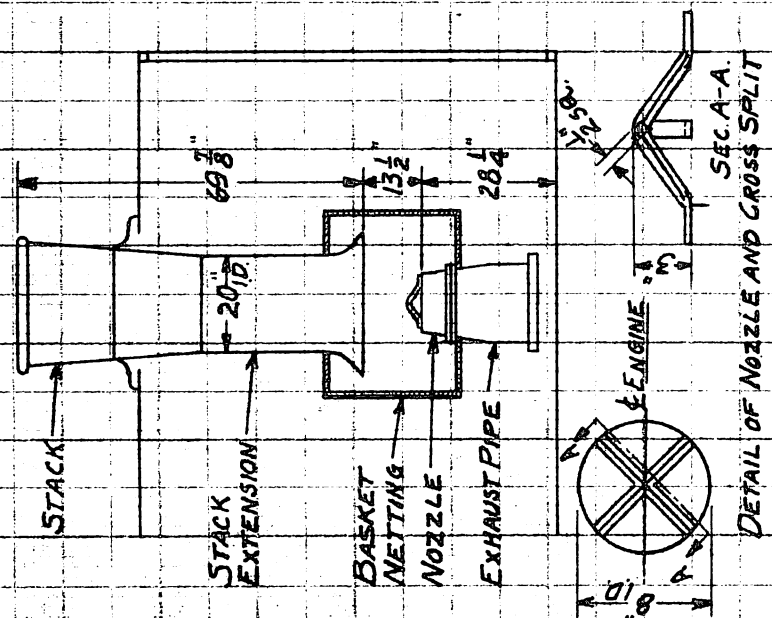
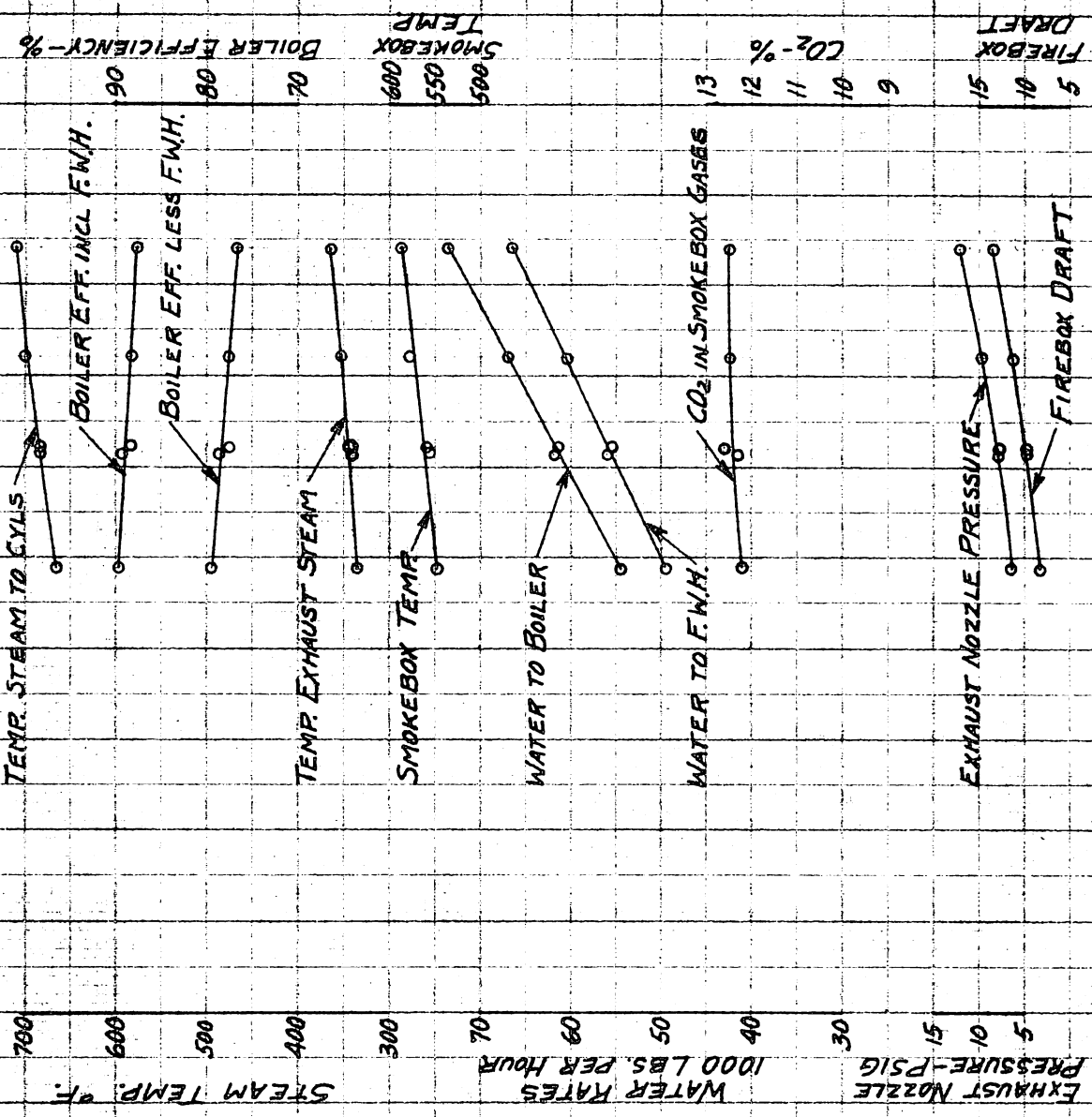


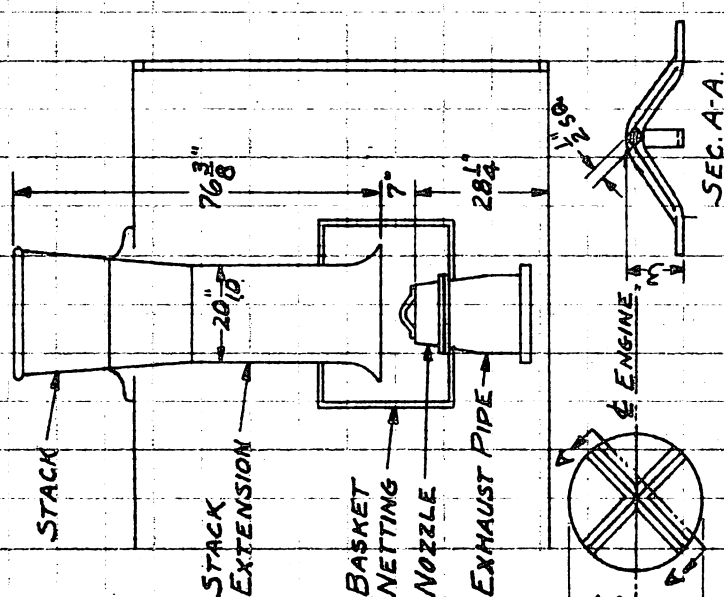
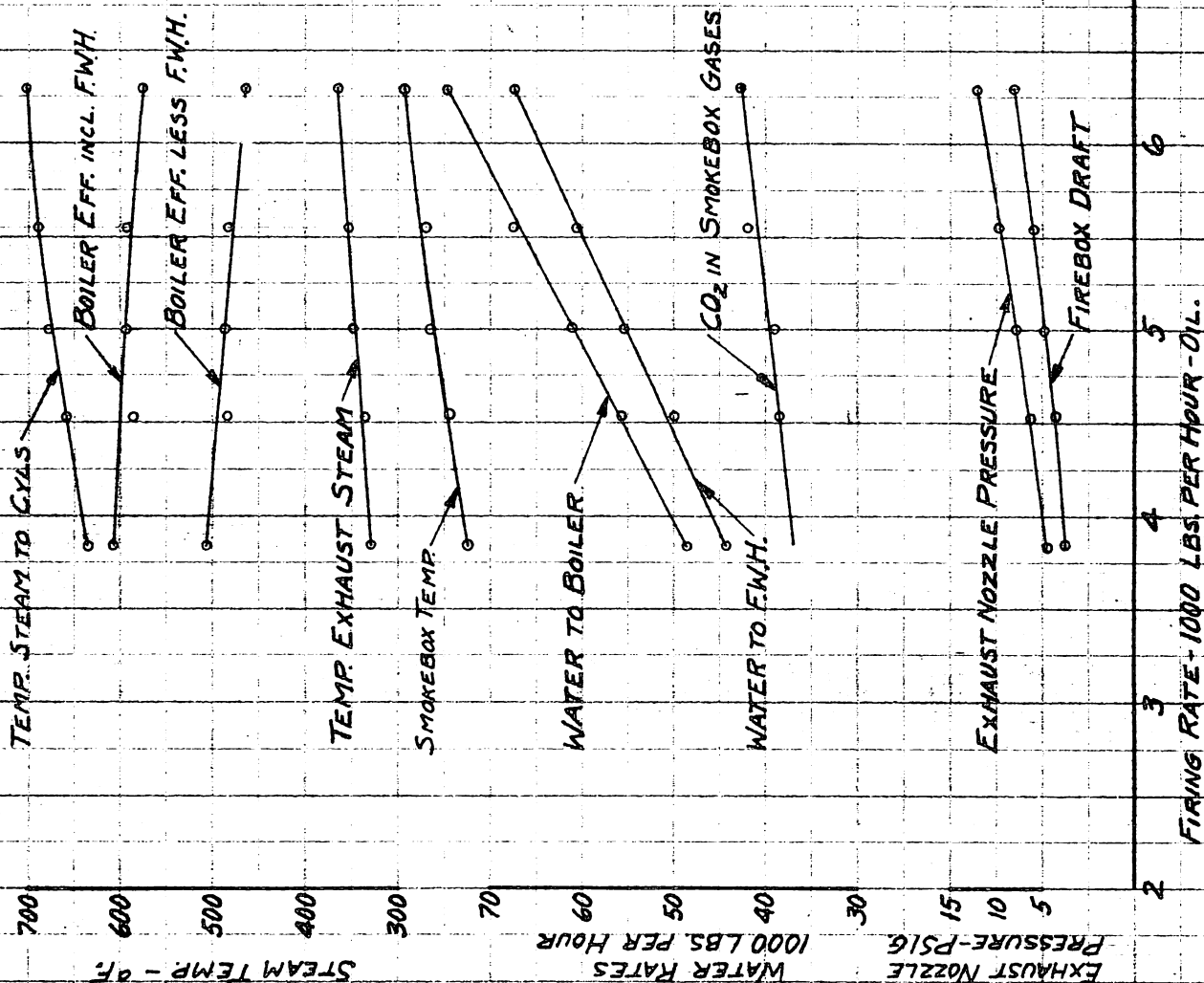
FIG. 2-7



SERIES SND
8" DIA. NOZZLE WITH
1/2" BASKET BRIDGE
CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO
APRIL 1, 1948

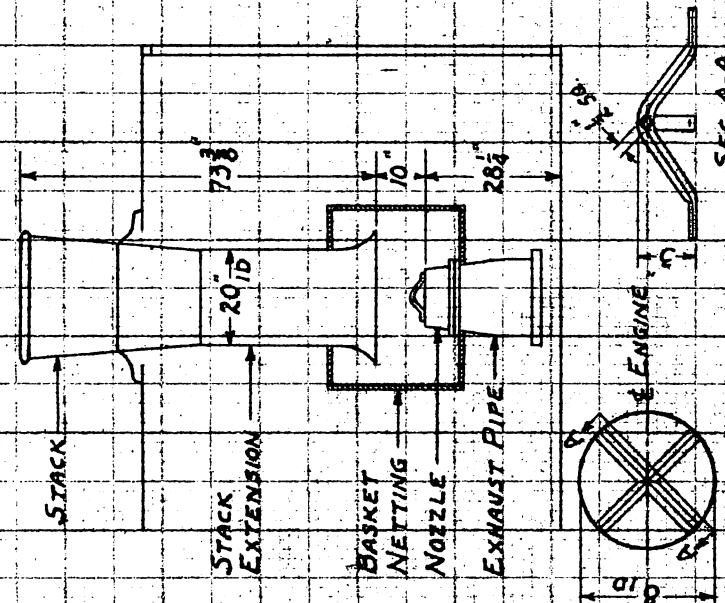
FIG. 2-8



SERIES SNE
8" DIA. NOZZLE WITH
1" BASKET BRIDGE
2" CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO
APRIL 1, 1948

Fig. 2-9



DETAIL OF NOZZLE AND CROSS SPLIT

SERIES 5NF
8" DIA. NOZZLE WITH
1/2 BASKET BRIDGE
CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO
APRIL 1, 1948

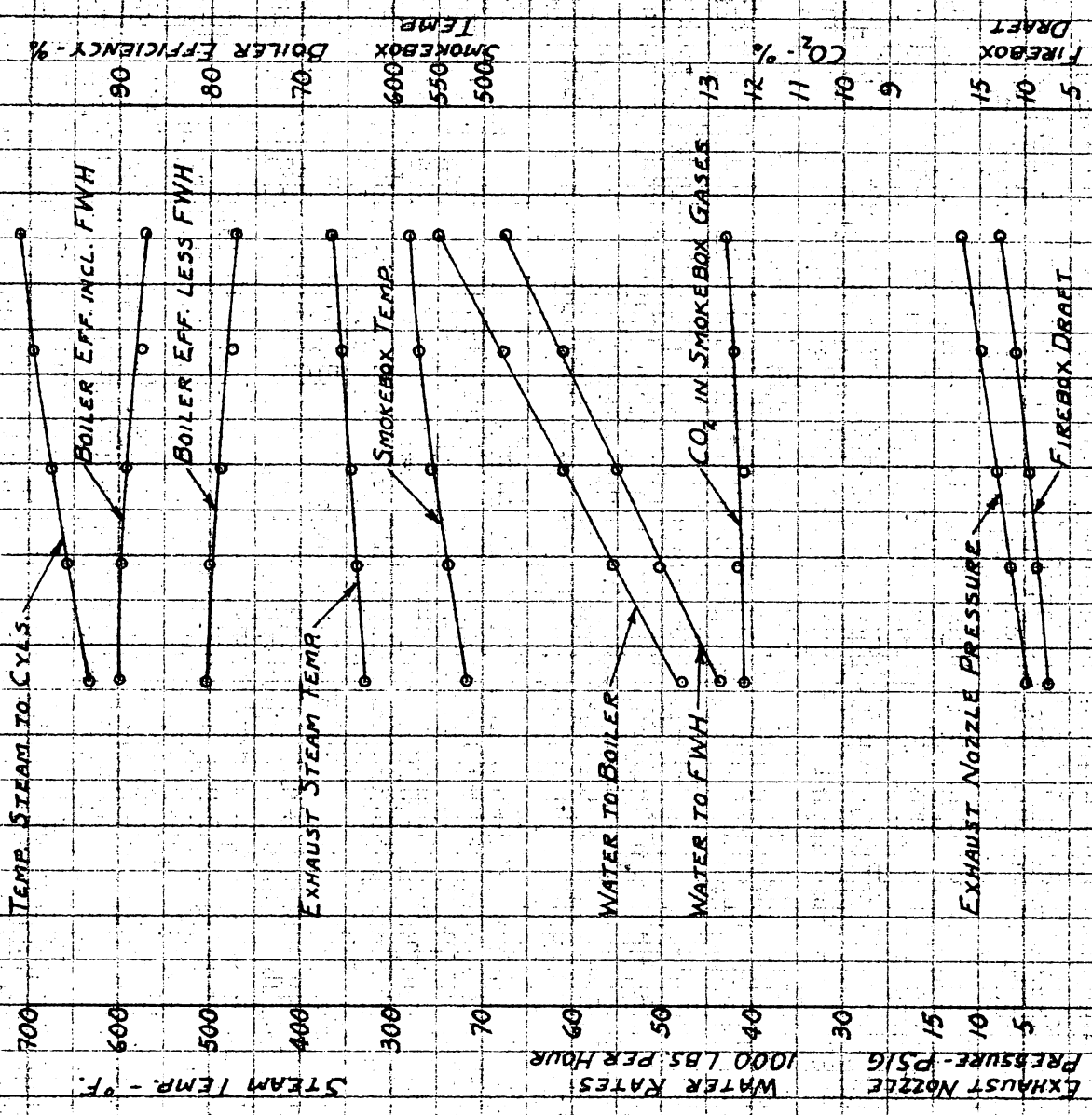
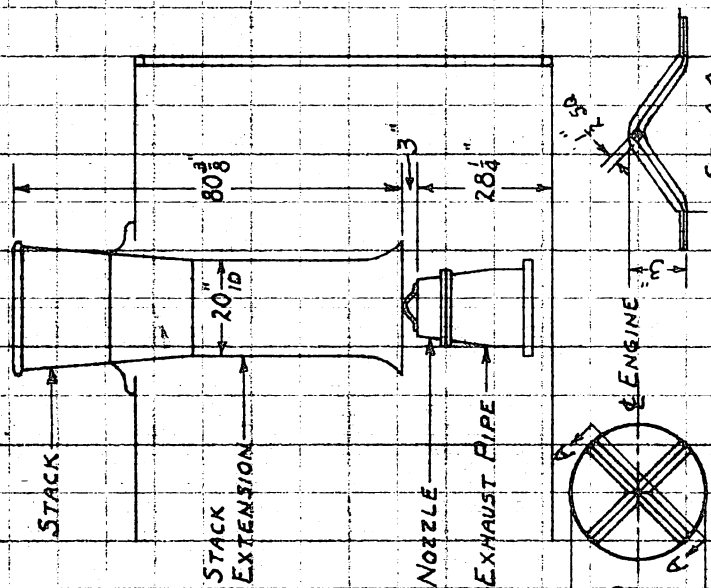


FIG. 2-10

NOTE: SPARK ARRESTER NOT USED
ACCOUNT INTERFERENCE
WITH LOWERED STACK.



DETAIL OF NOZZLE AND CROSS SPLIT

SERIES SNG
8" DIA. NOZZLE WITH
1/2" BASKET BRIDGE
CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO
APRIL 1, 1948

ST-137

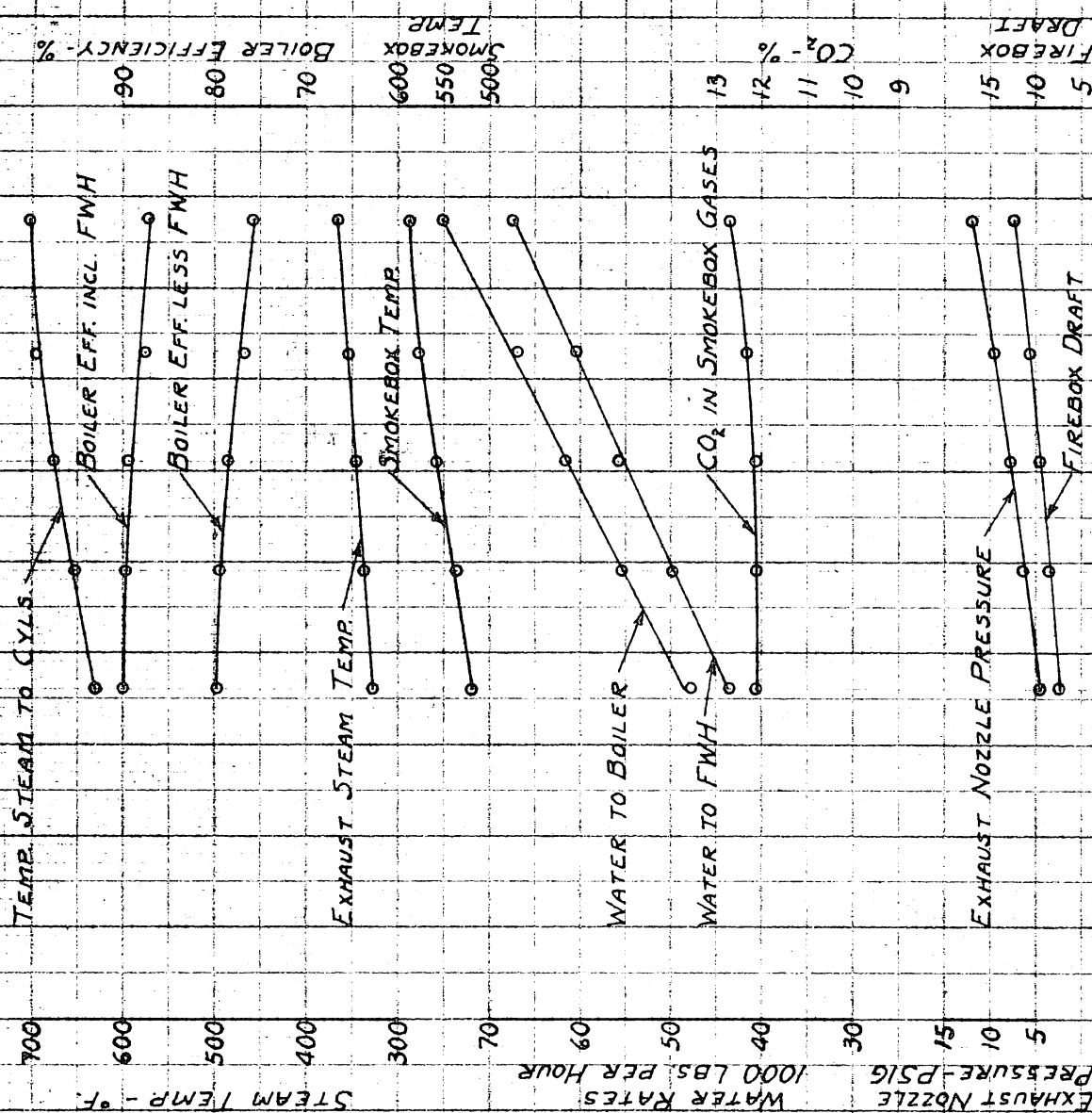
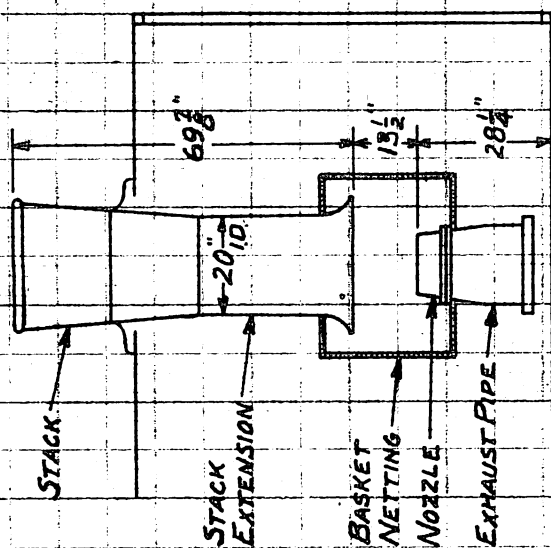
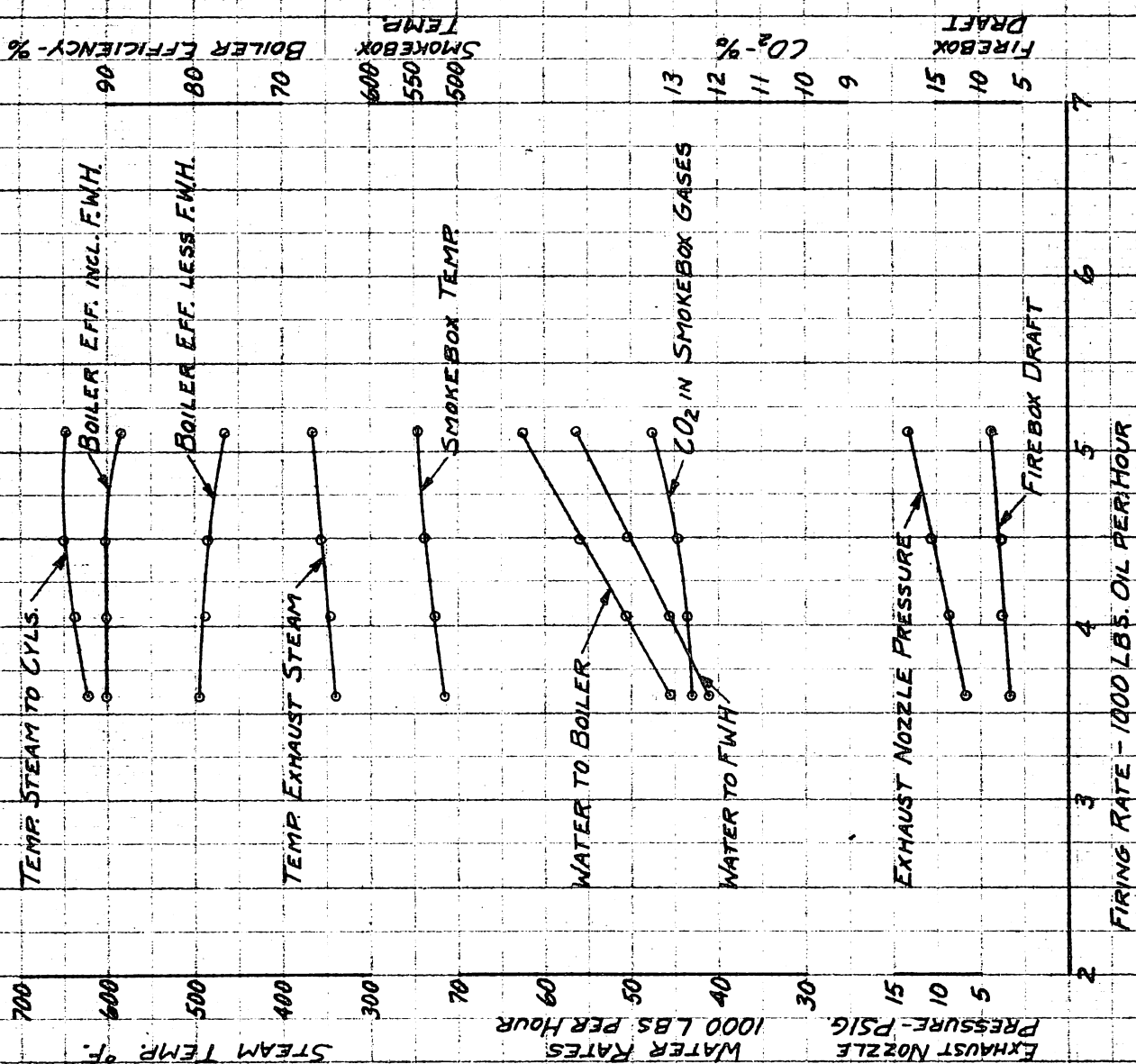


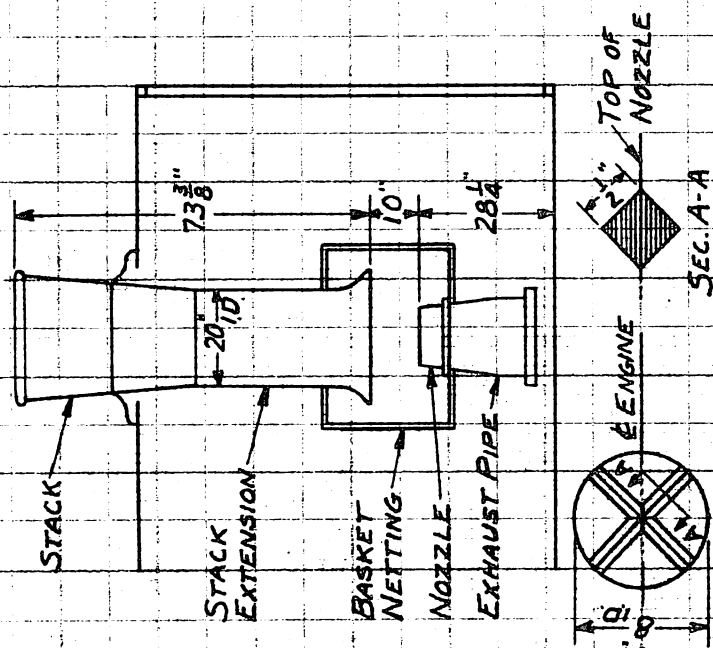
FIG. 2-11



SERIES 5N1
7.087" DIA. NOZZLE WITH
NO CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO
APRIL 1, 1948

Fig. 2-12



DETAIL OF NOZZLE AND CROSS SPLIT.

SERIES 5NJ
8" DIA NOZZLE WITH
1/2" CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO.
APRIL 1, 1948

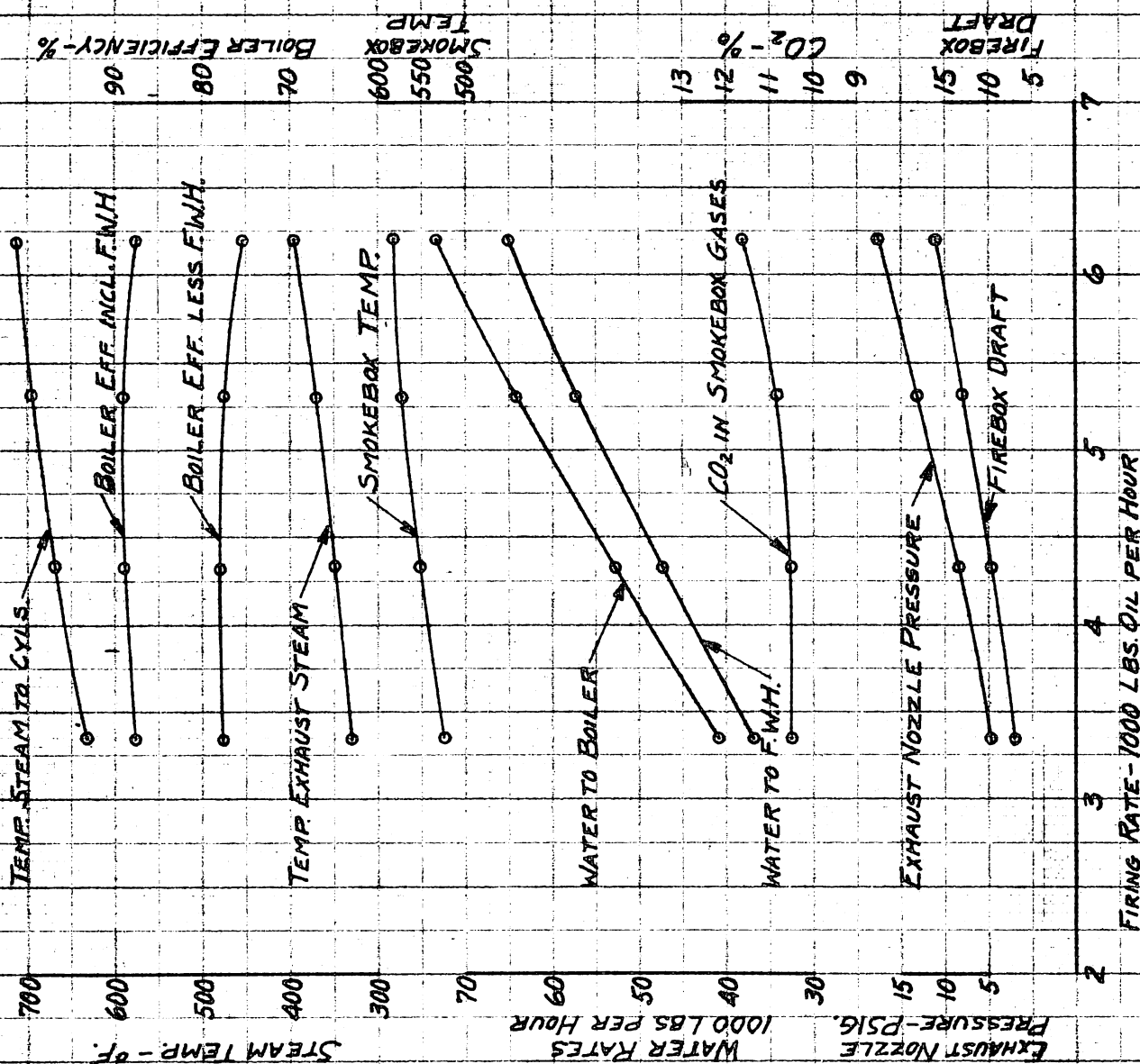
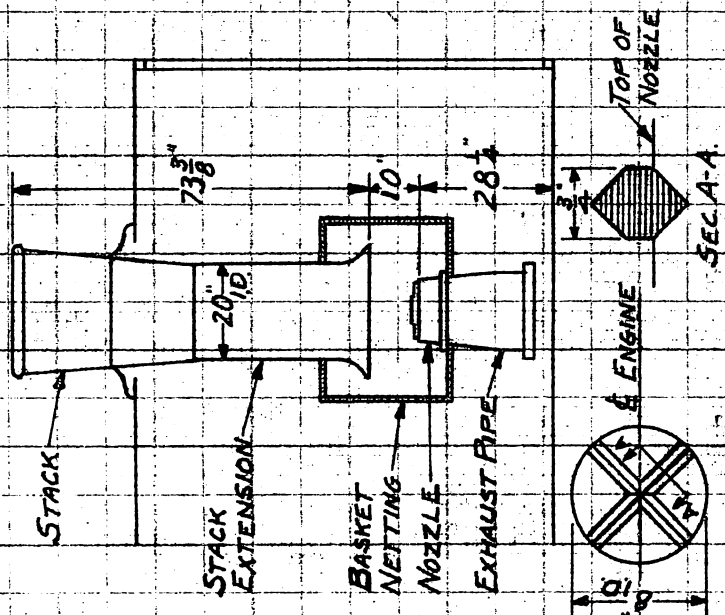


Fig. 2-13



SERIES SNK 8" DIA NOZZLE WITH T&NO CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO
APRIL 1, 1948

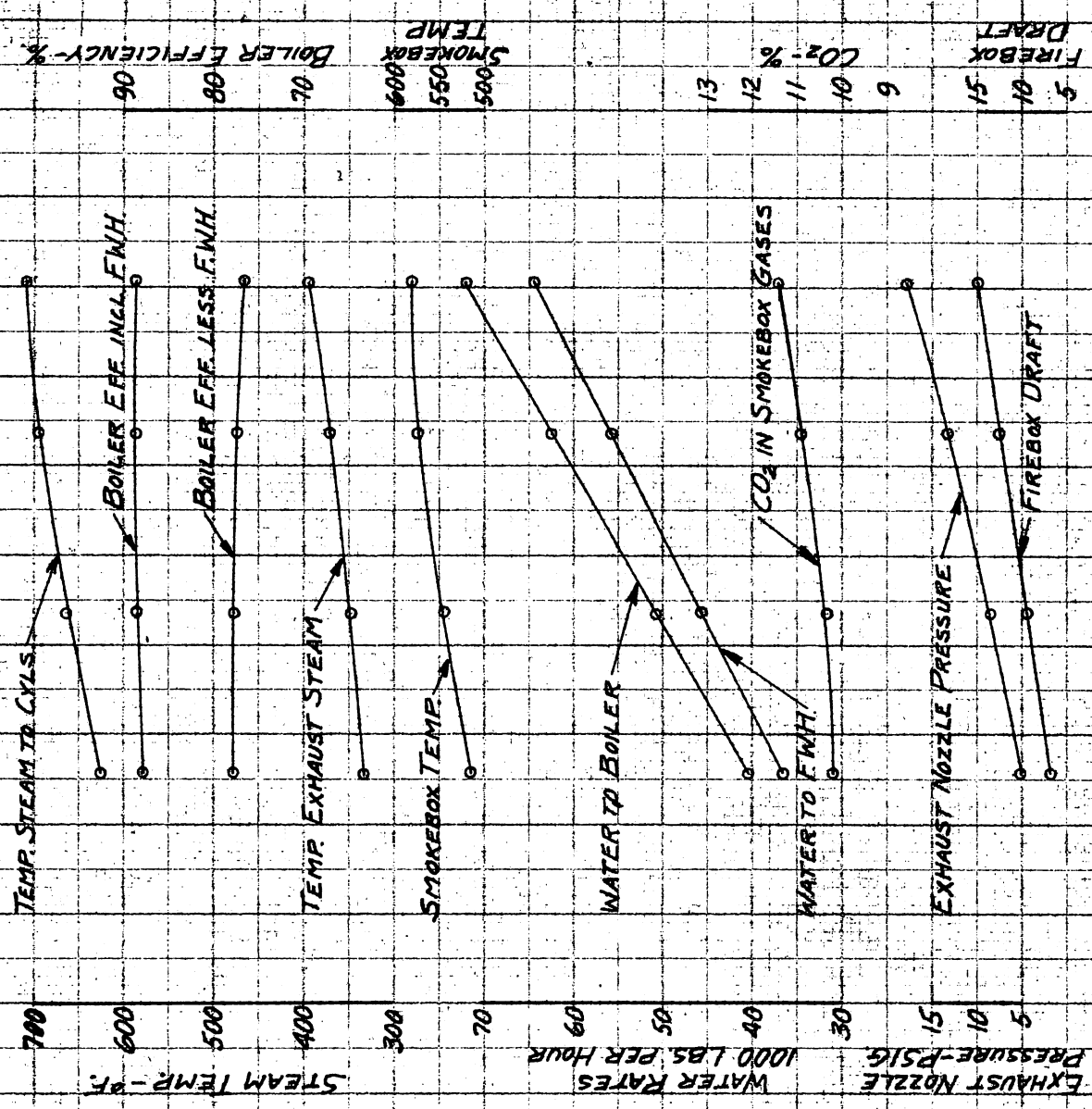


FIG. 2-14

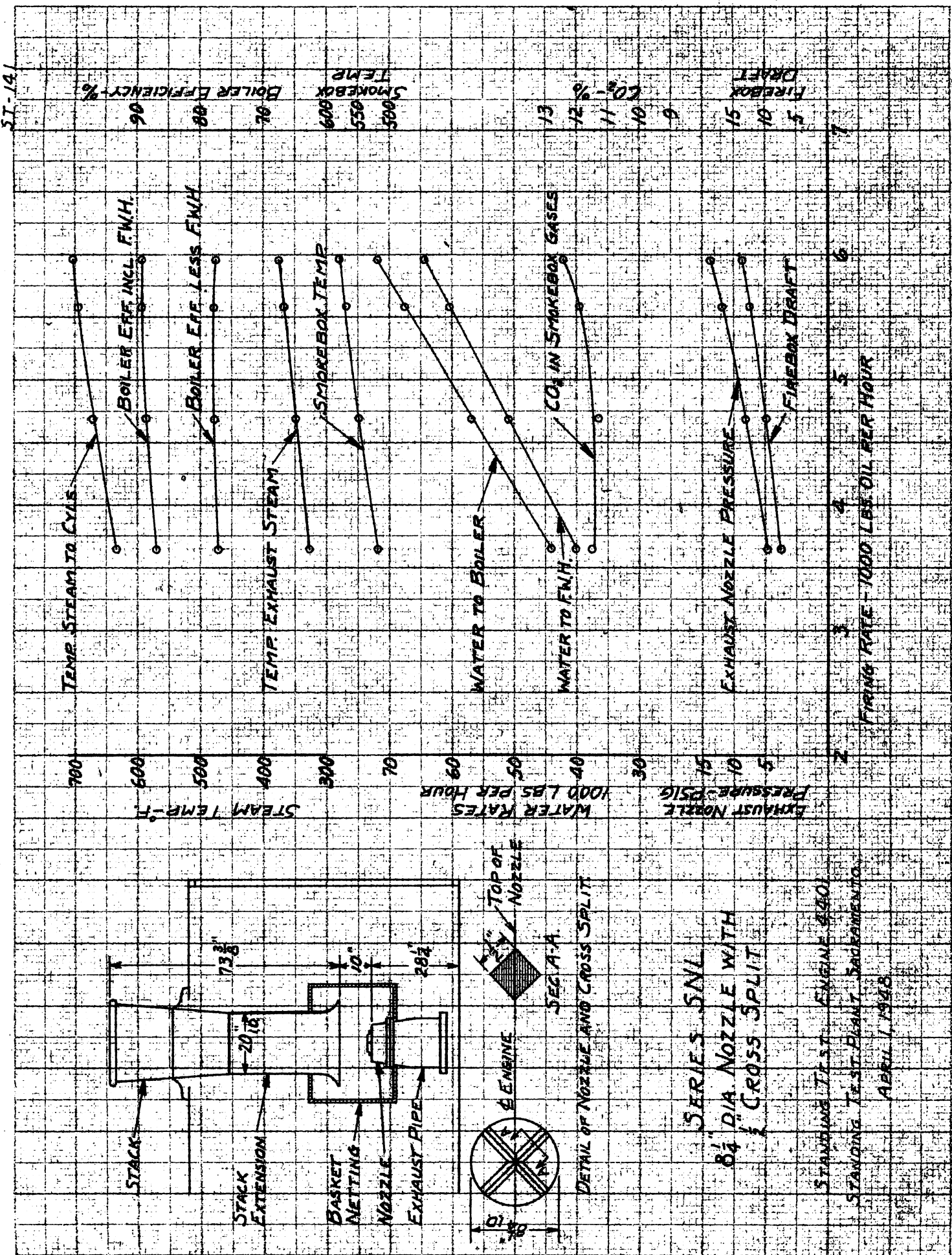
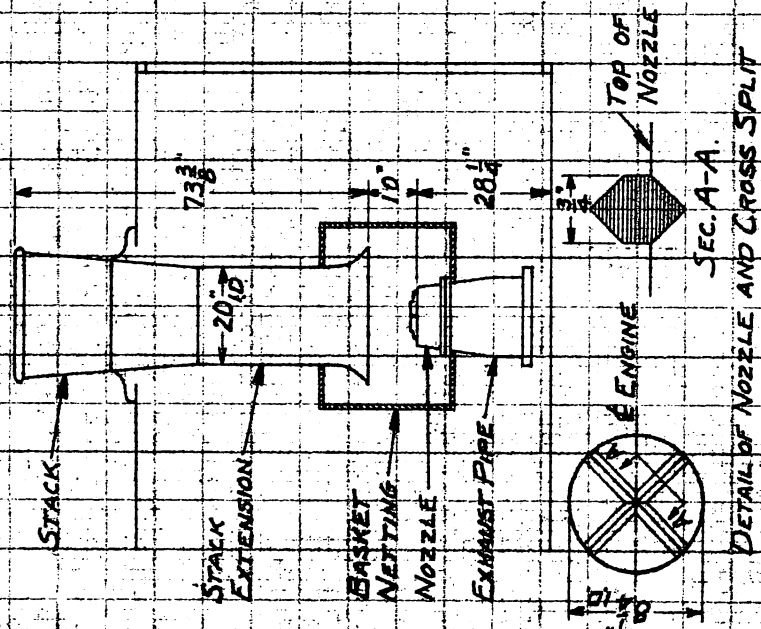


Fig. 2-15



SERIES SNM 8 1/2 DIA NOZZLE WITH T&NO CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO
APRIL 1, 1948

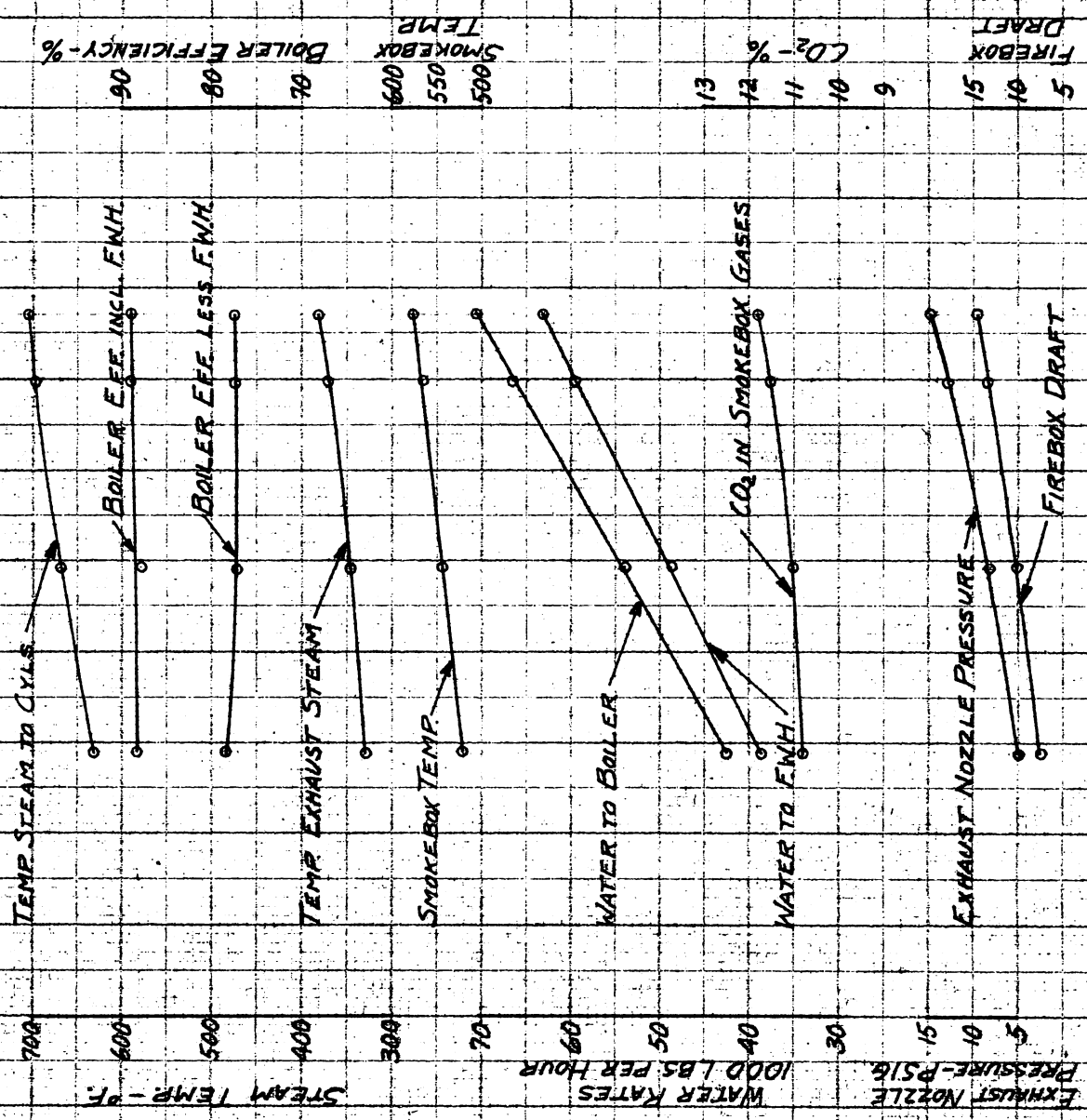
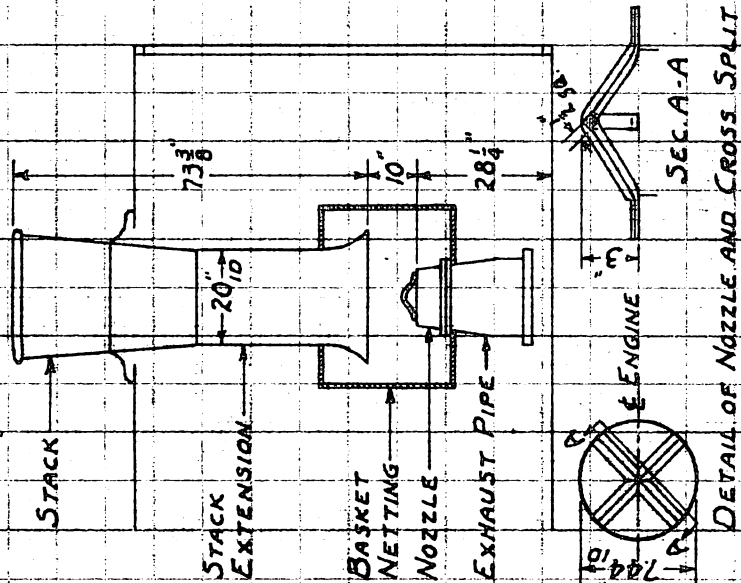


FIG. 2-16



SERIES SNN
7.44" DIA. NOZZLE WITH
1/2 BASKET BRIDGE
CROSS SPLIT

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO
APRIL 1, 1948

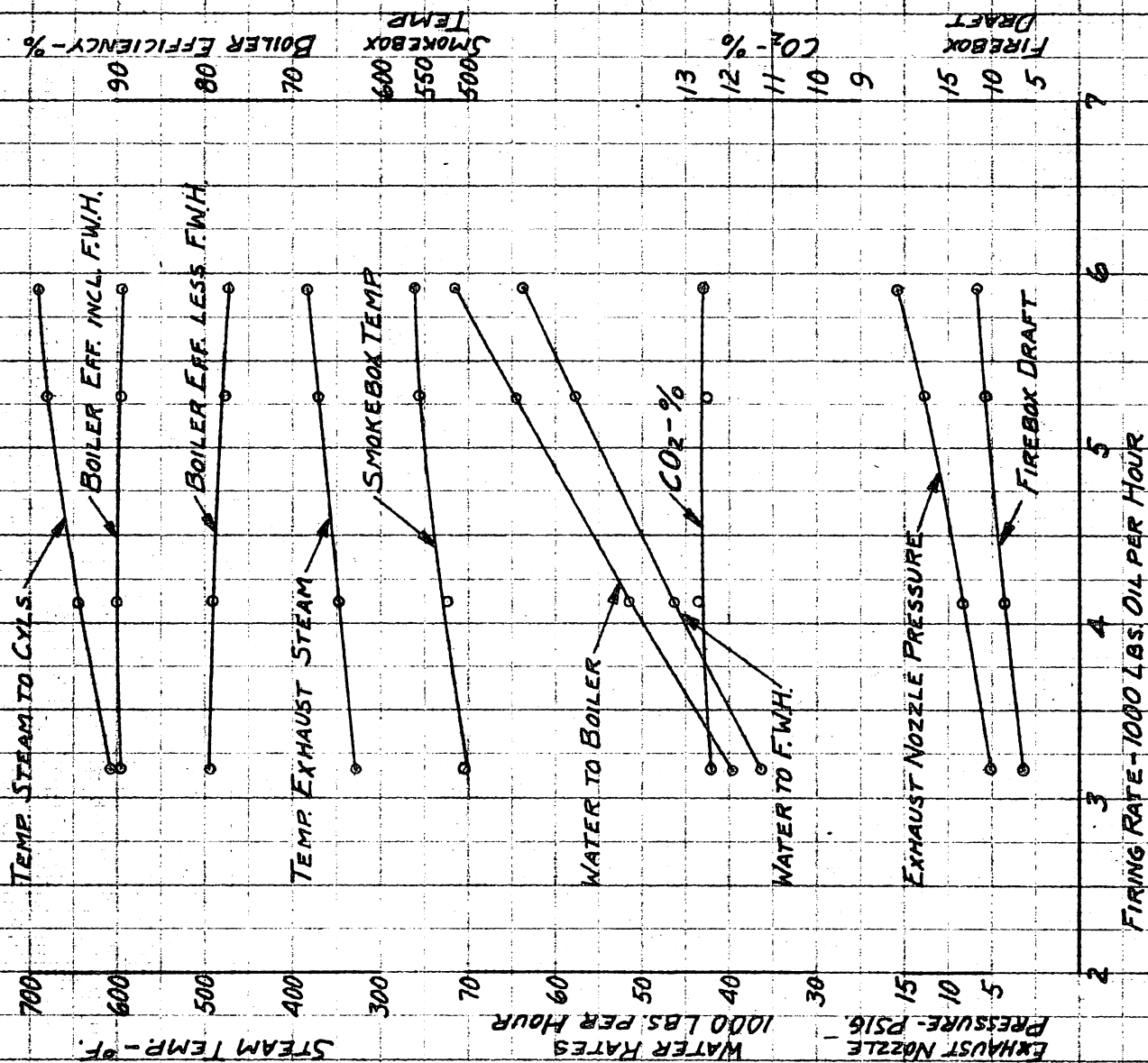


Fig 2-17

FIRING RATE 5000 LBS OIL PER HOUR

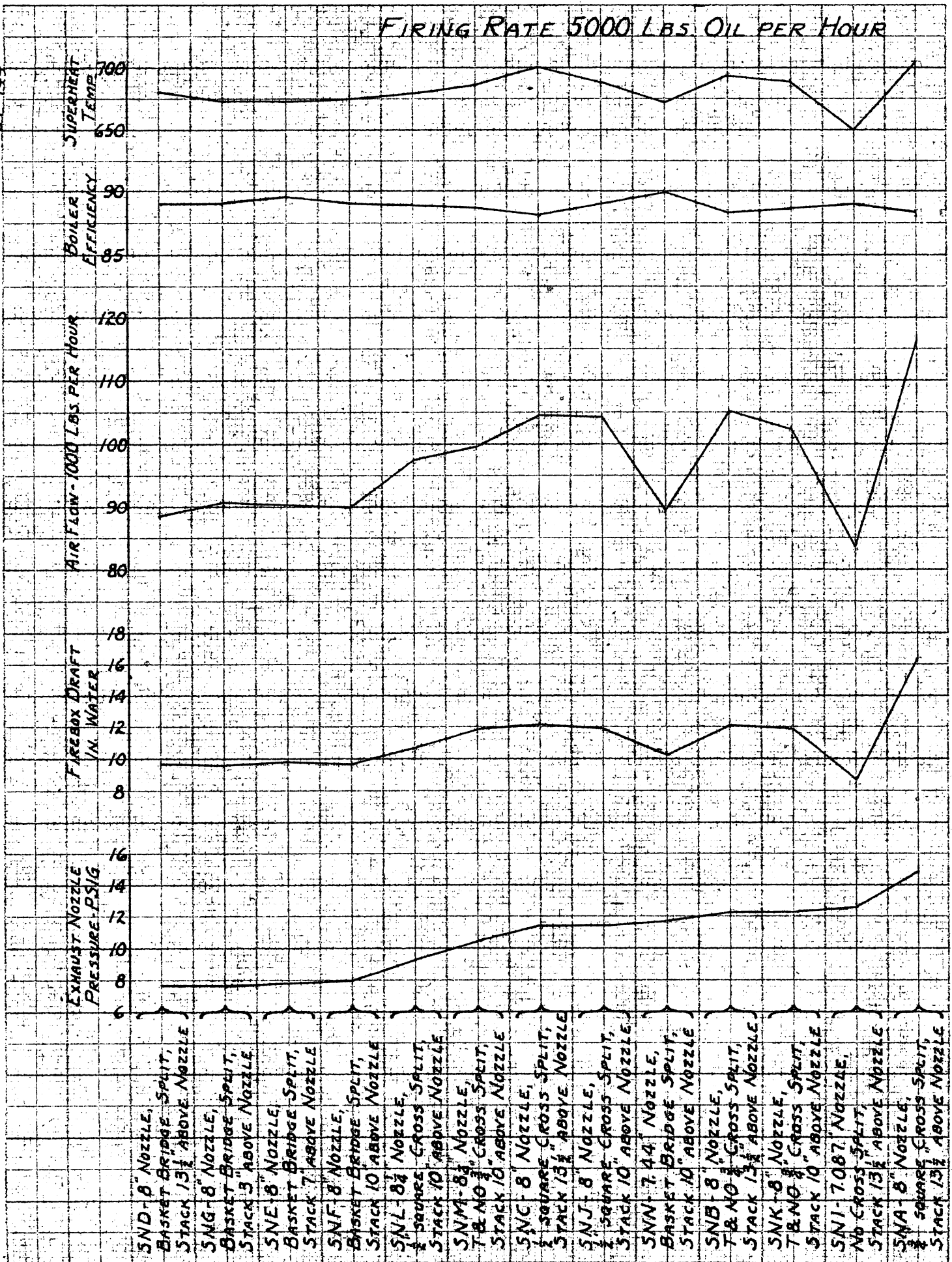
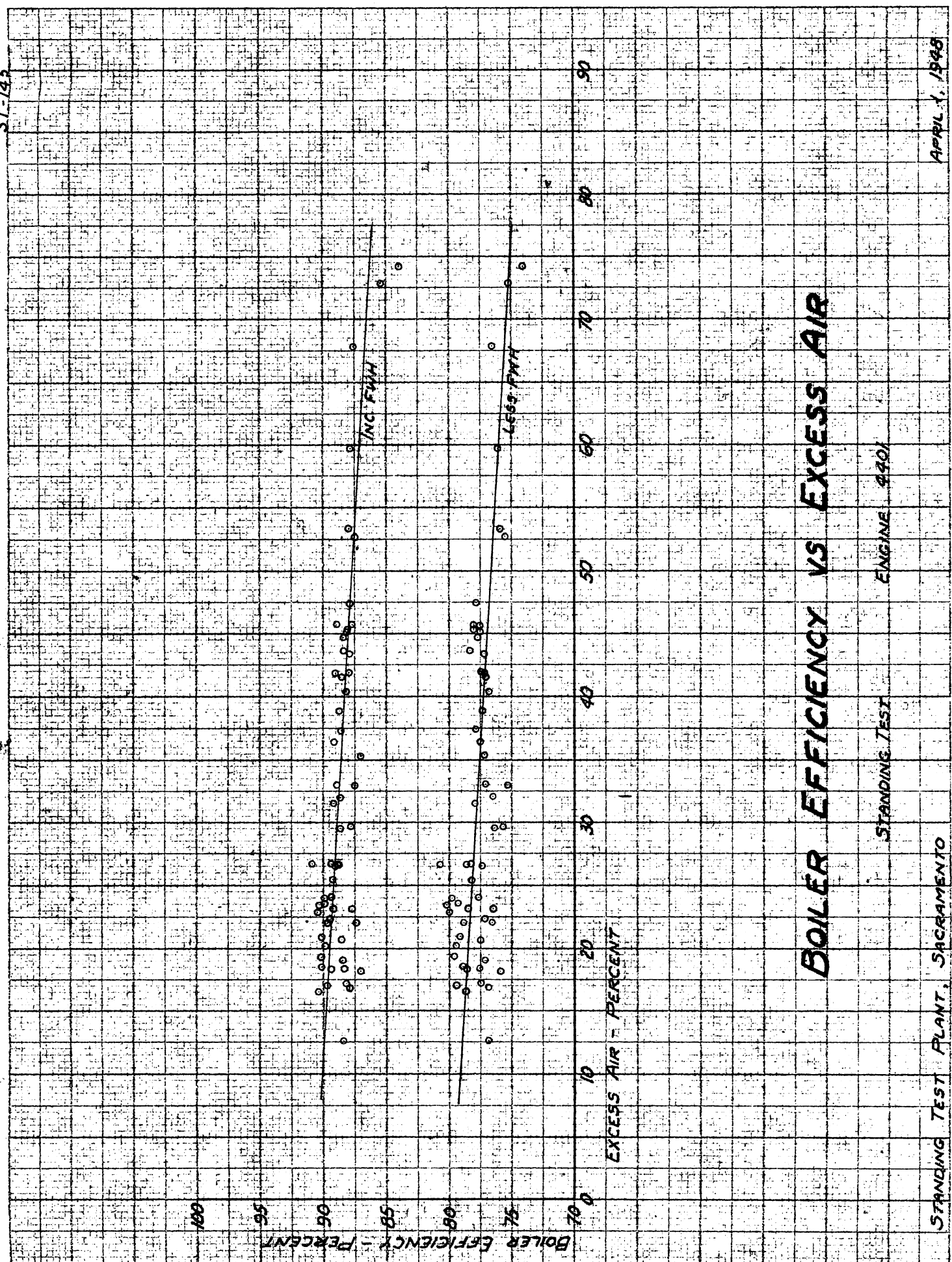


FIG. 2-18

ST-145



BOILER EFFICIENCY VS EXCESS AIR

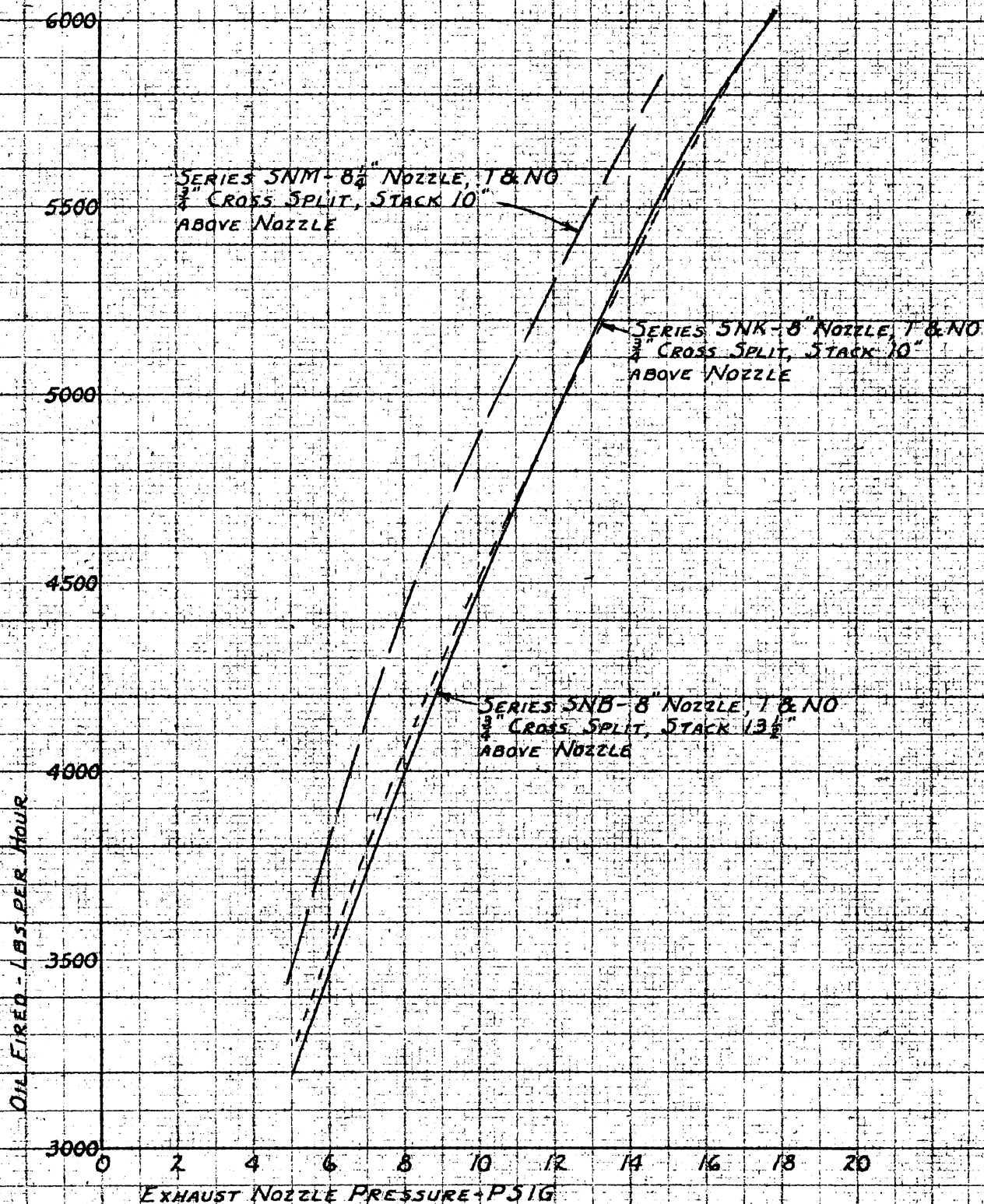
STANDING TEST ENGINE 4901

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1949

FIG. 2-19

57-146



FIRING RATE VS EXHAUST NOZZLE PRESSURE

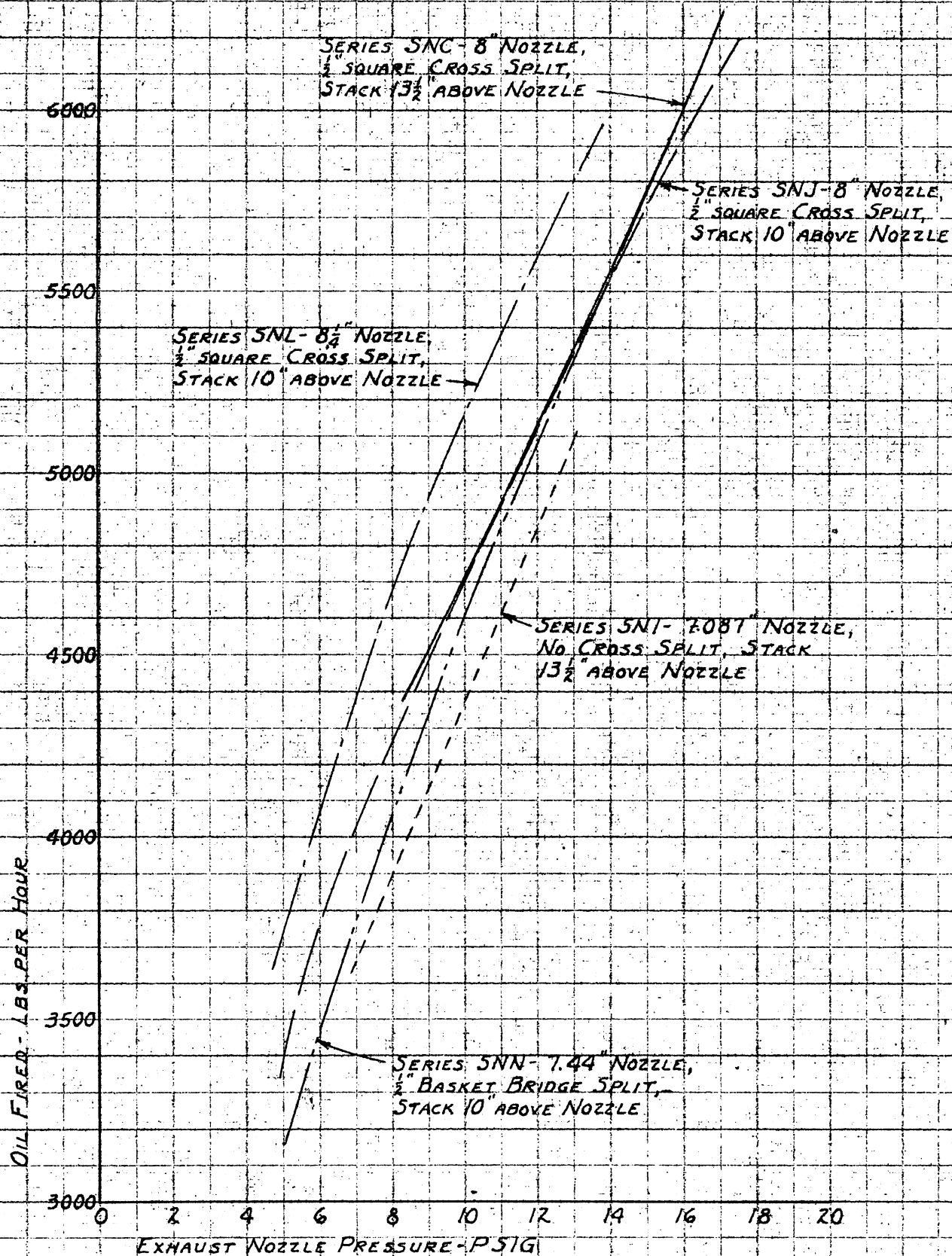
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-20

ST-147



FIRING RATE VS EXHAUST NOZZLE PRESSURE

STANDING TEST

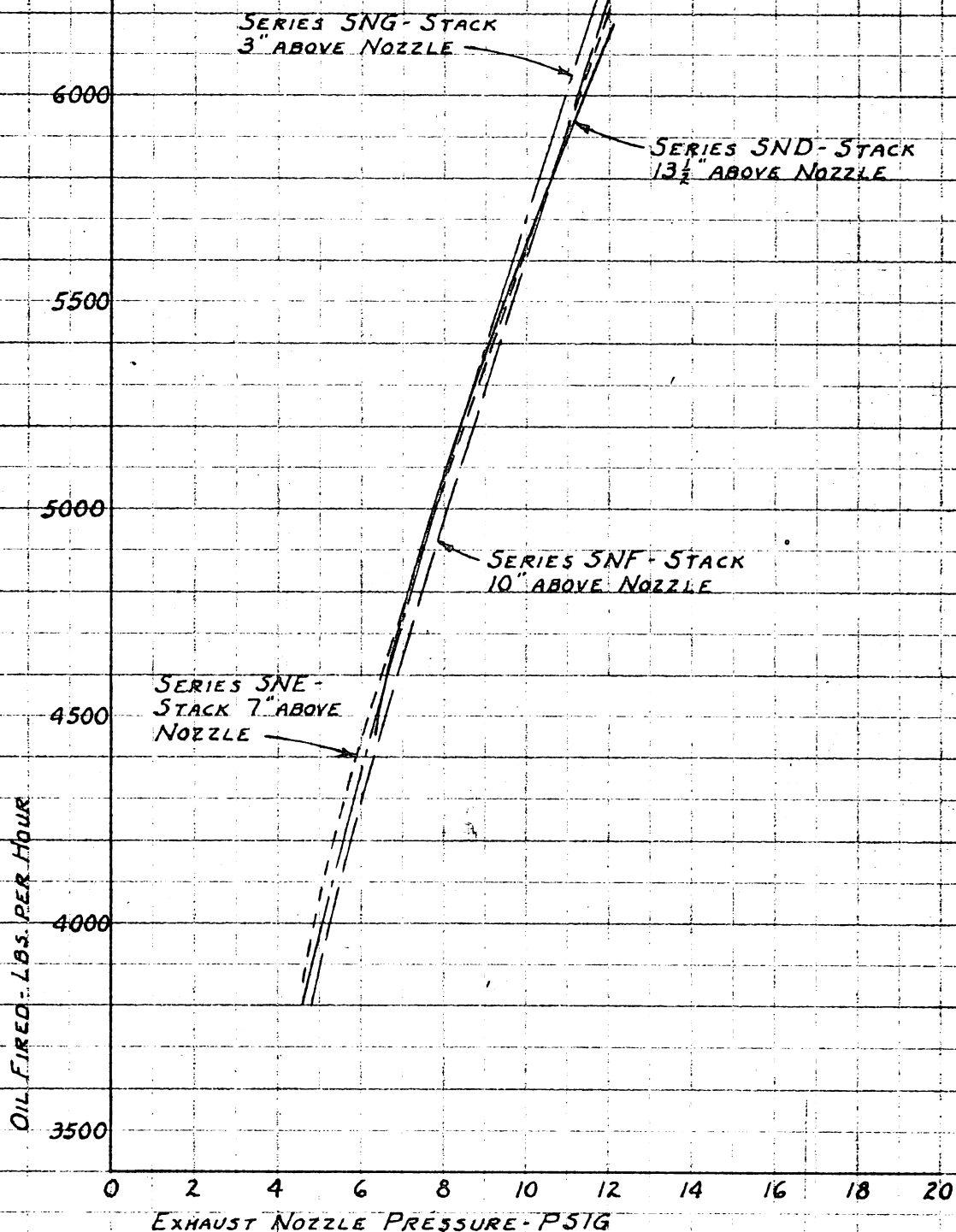
ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-21

ST-148



FIRING RATE VS EXHAUST NOZZLE PRESSURE

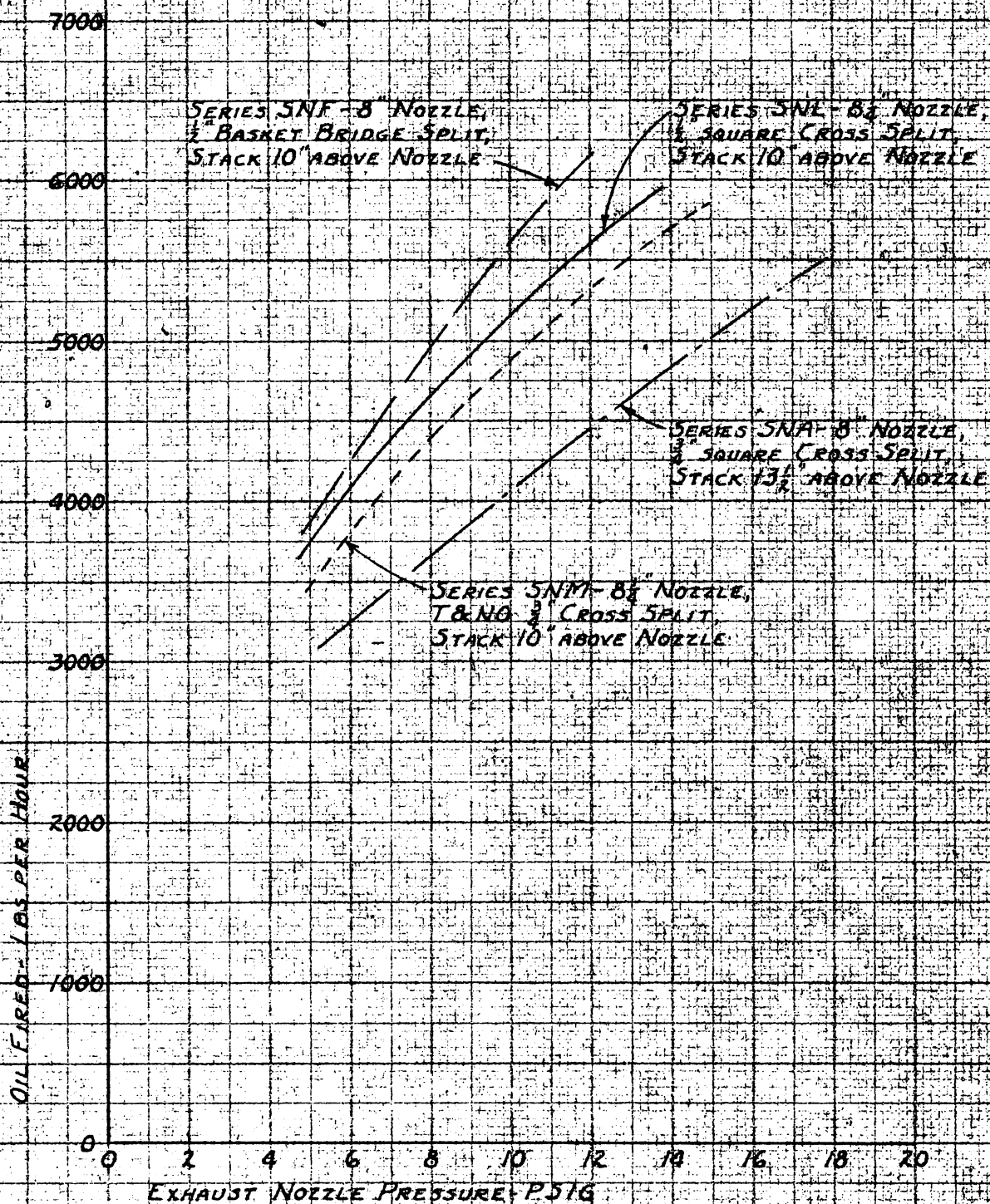
8" DIA. NOZZLE WITH 1/2" SQUARE
BASKET BRIDGE CROSS SPLIT

STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-22



FIRING RATE VS EXHAUST NOZZLE PRESSURE

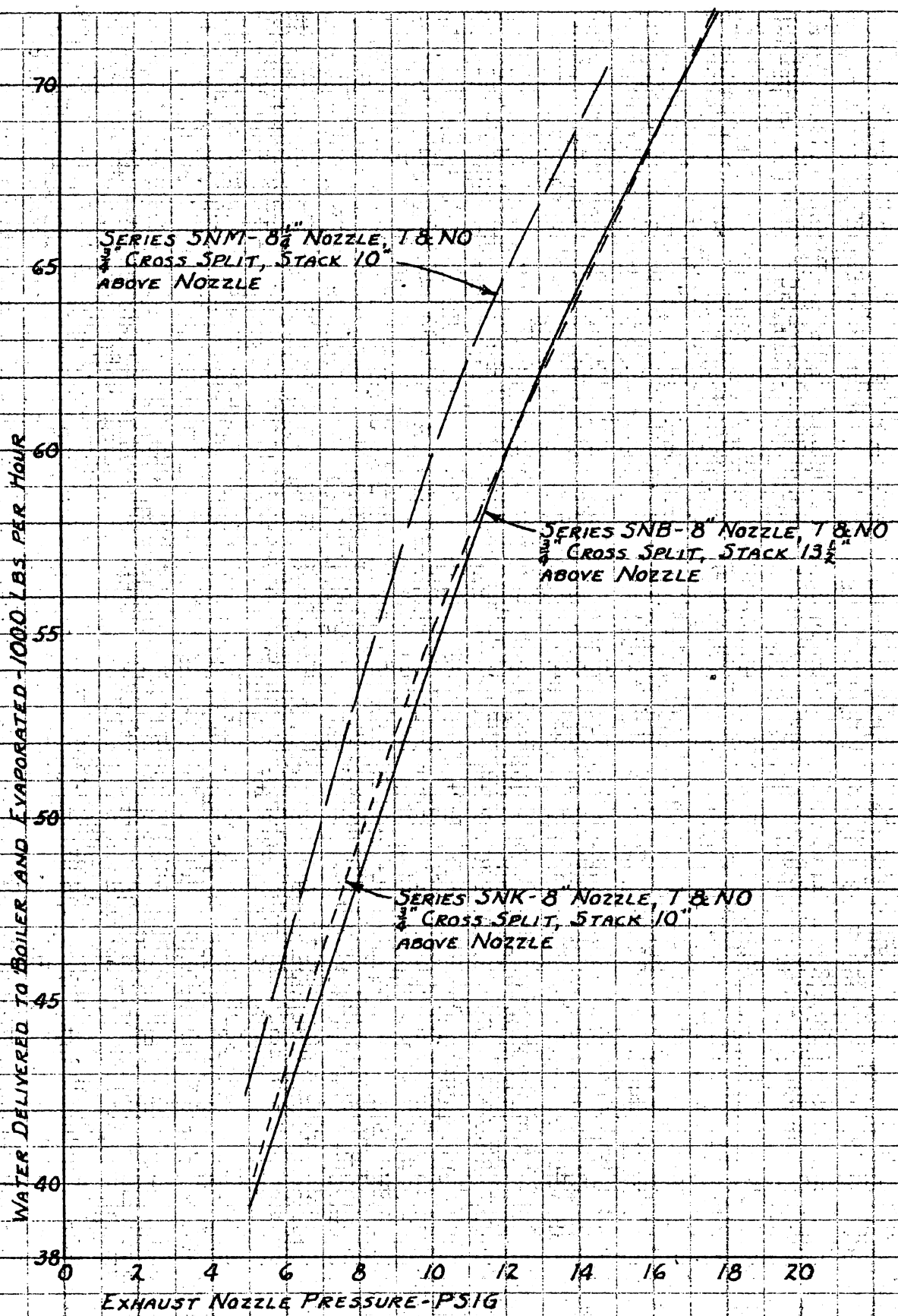
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG 2-23

ST-150



WATER RATE VS EXHAUST NOZZLE PRESSURE

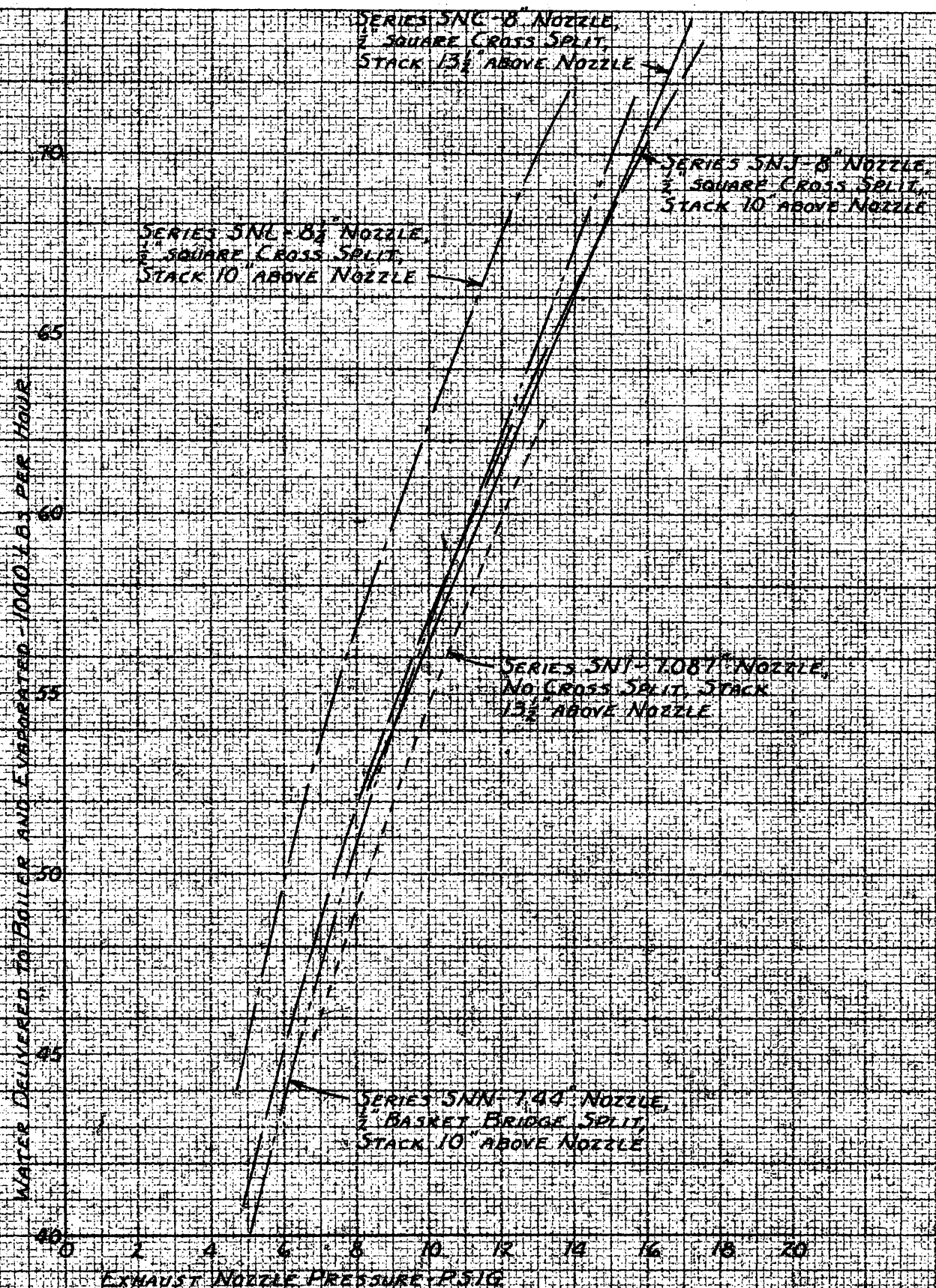
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-24

ST-151



WATER RATE VS EXHAUST NOZZLE PRESSURE

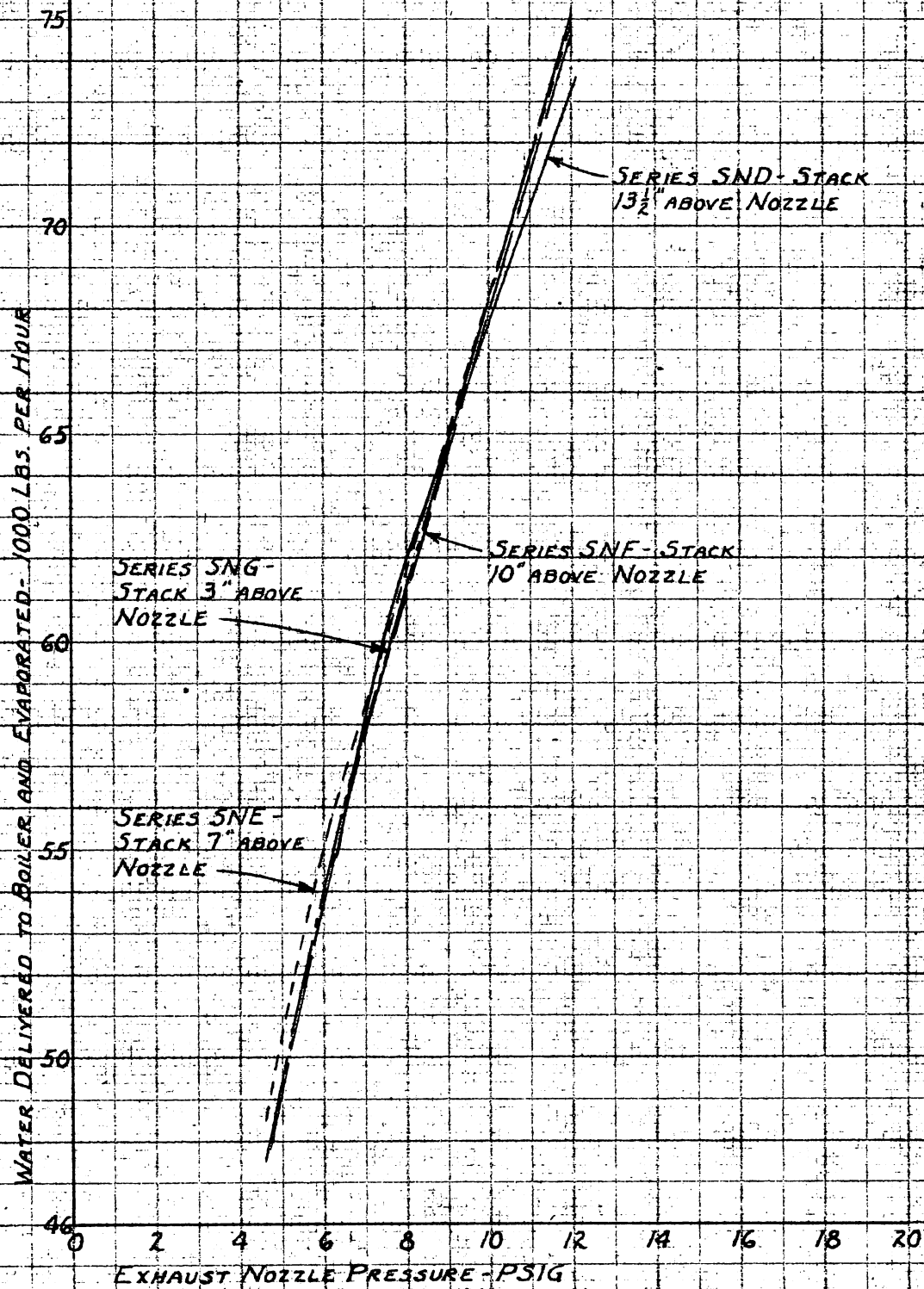
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 6, 1948

Fig. 2-25

ST-152



WATER RATE VS EXHAUST NOZZLE PRESSURE

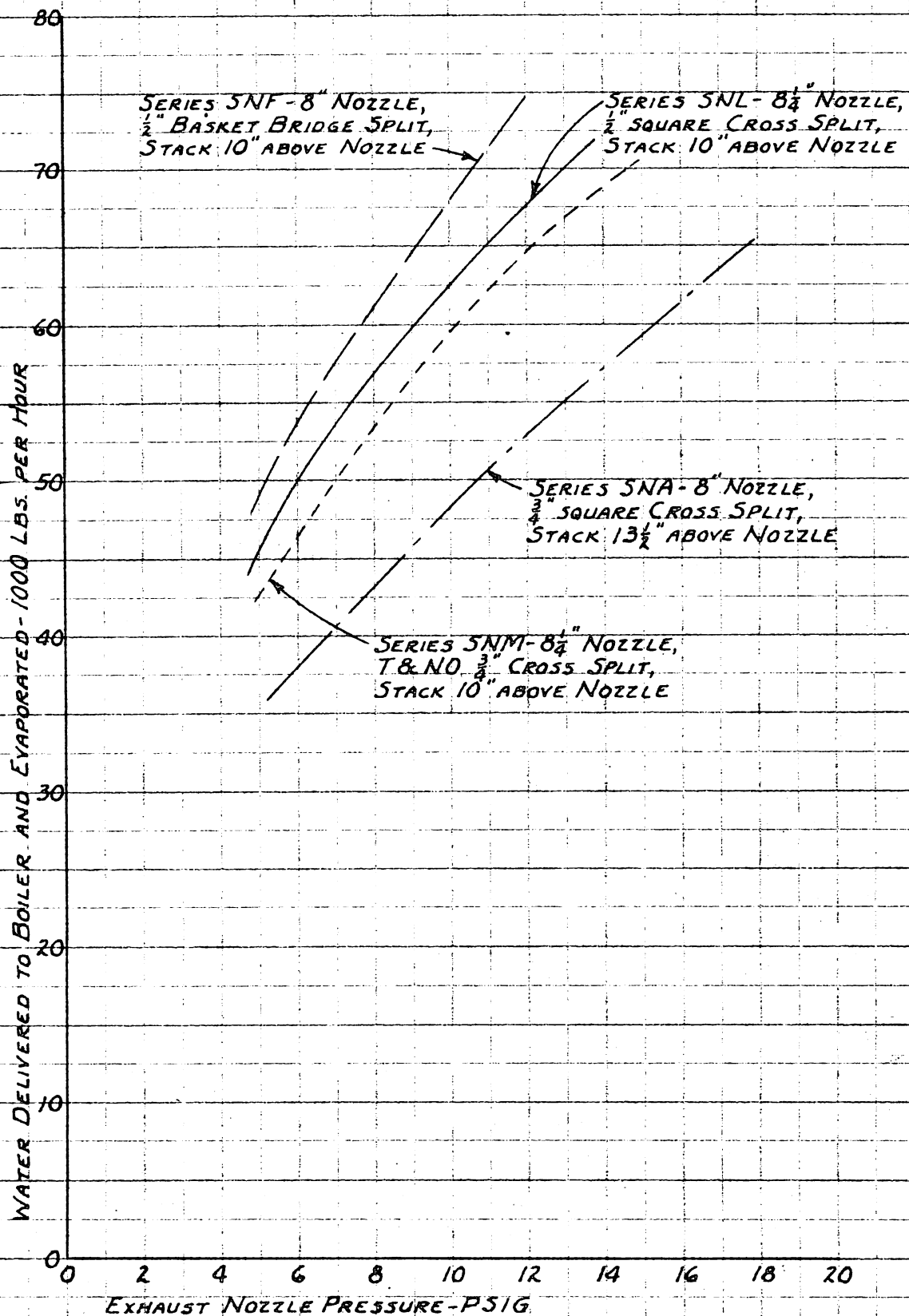
8" DIA. NOZZLE WITH $\frac{1}{2}$ " SQUARE BASKET BRIDGE CROSS SPLIT

STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-26



WATER RATE VS EXHAUST NOZZLE PRESSURE

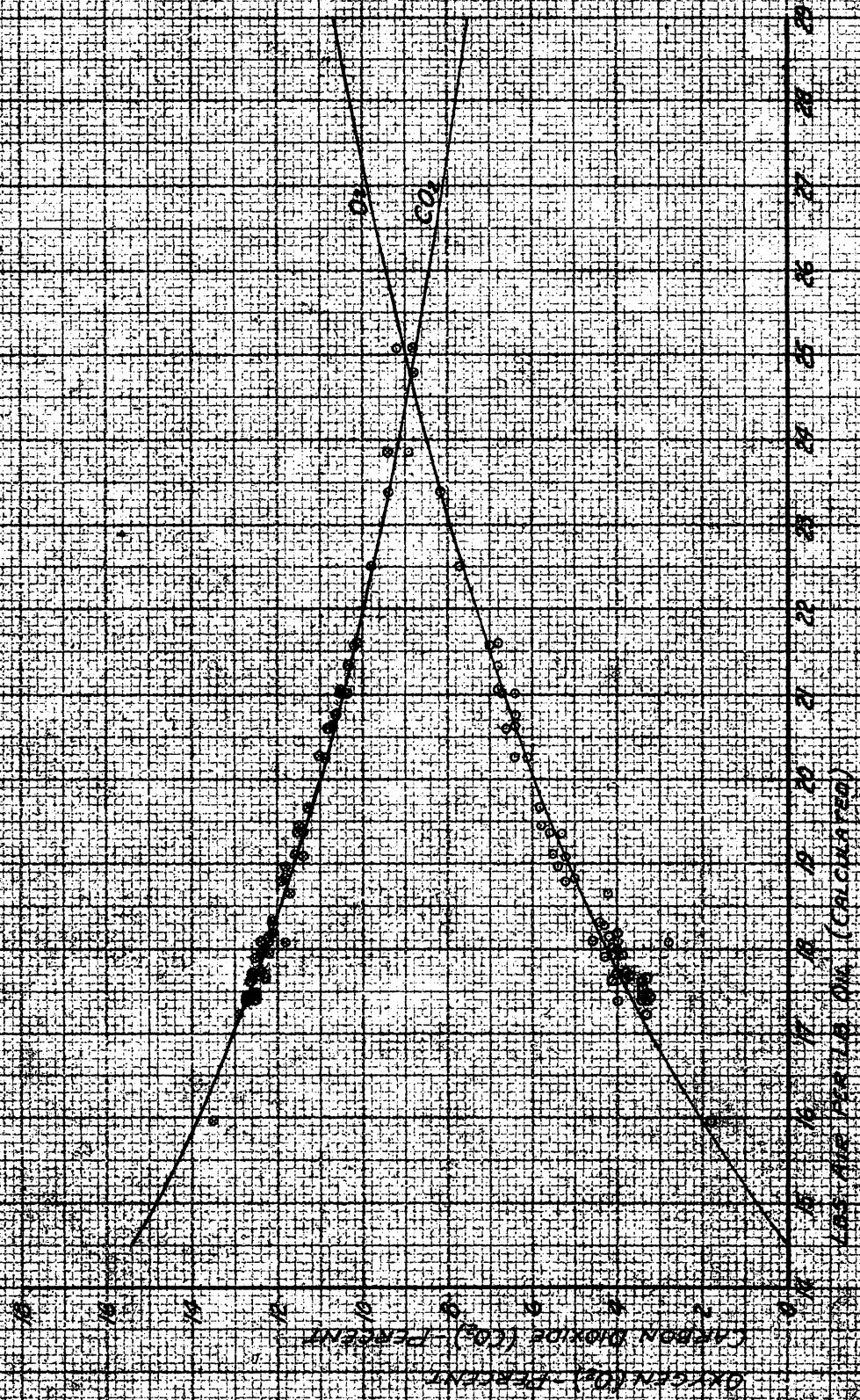
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-27

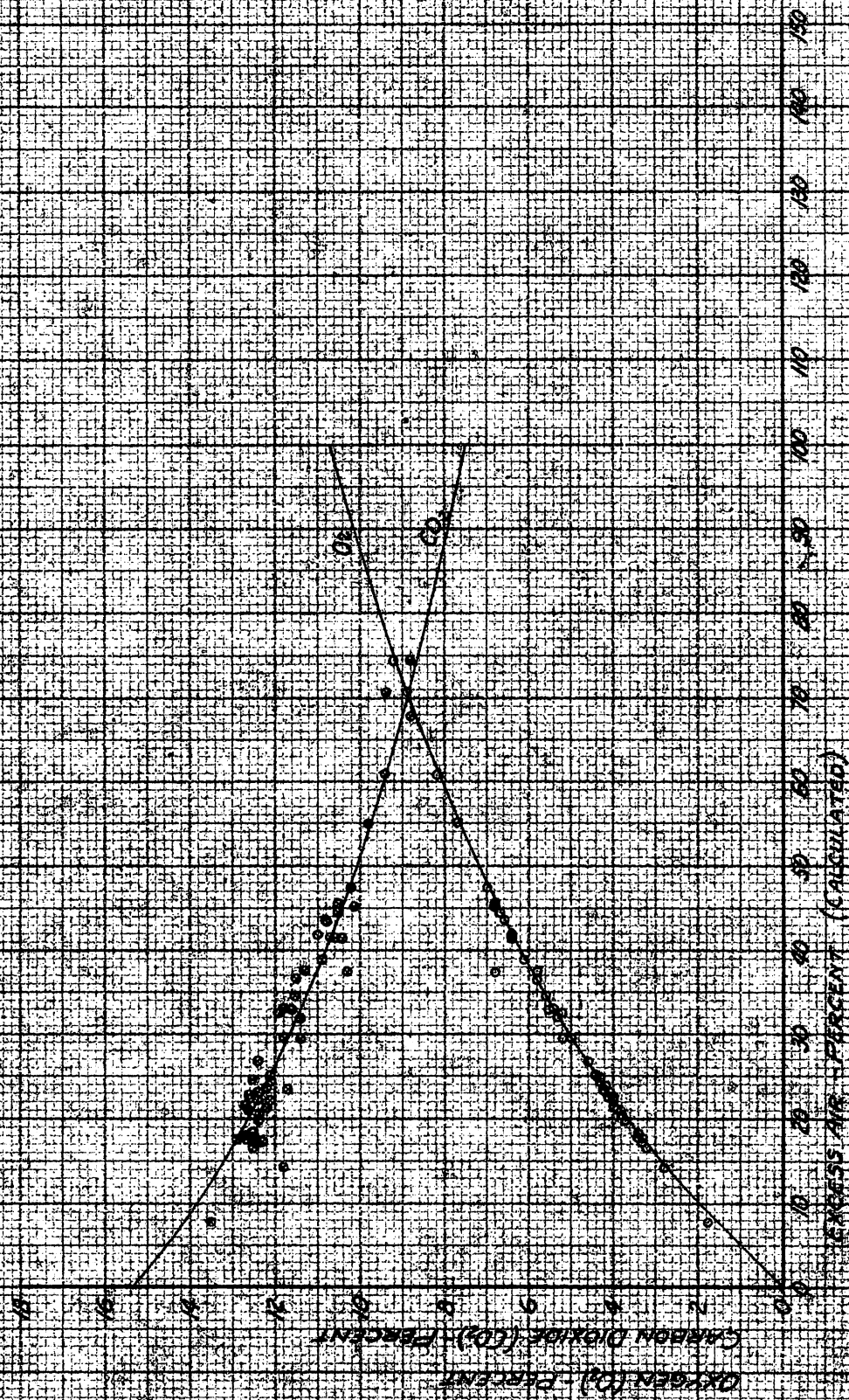
ST-154



CARBON DIOXIDE (CO_2) & OXYGEN (O_2) VS LBS. AIR PER LB. OIL

FIG. 2-28

57-155



CARBON DIOXIDE (CO₂) & OXYGEN (O₂) VS EXCESS AIR

FIG. 2-29

ST-156

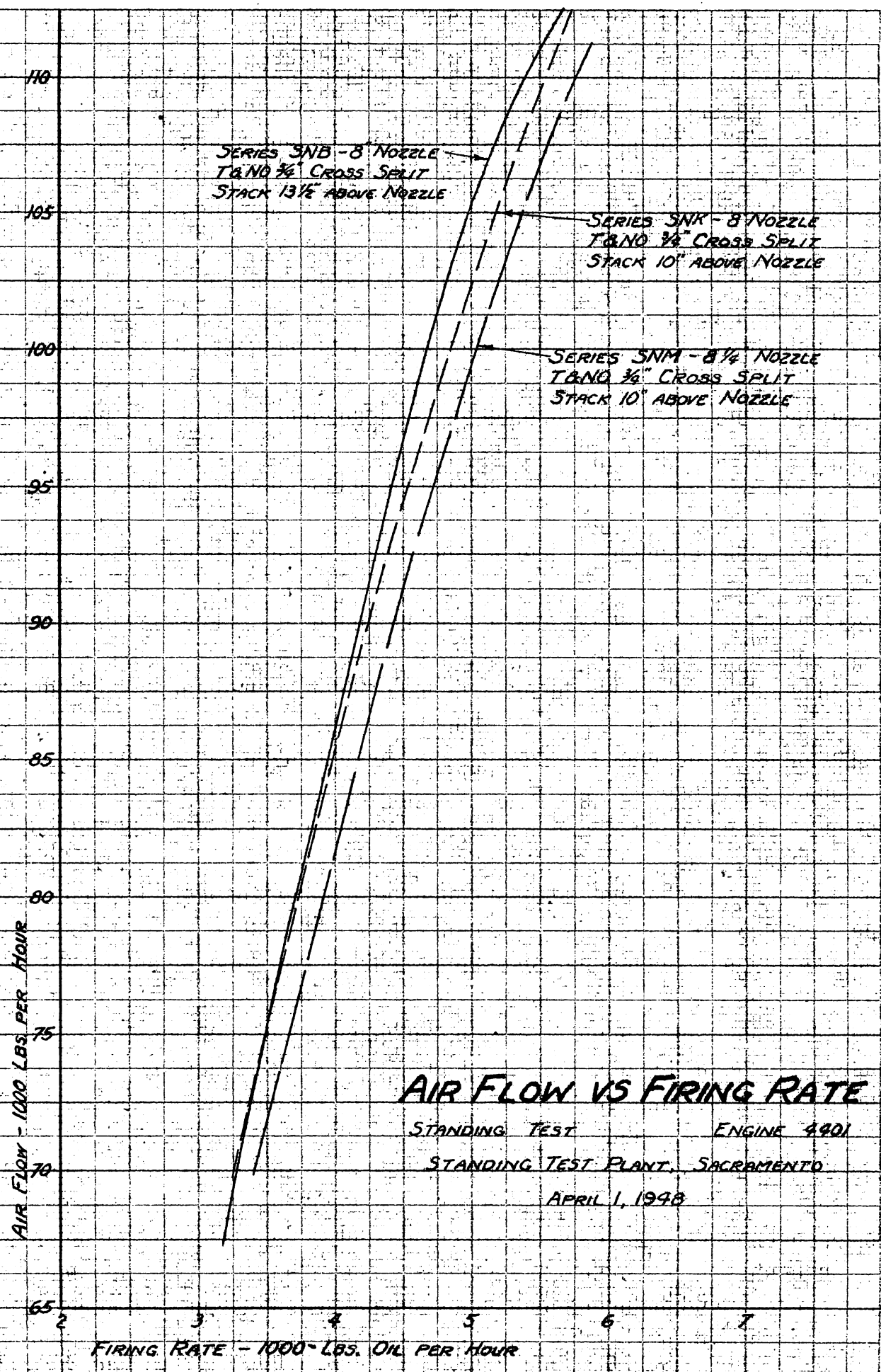


FIG. 2-30

ST-157

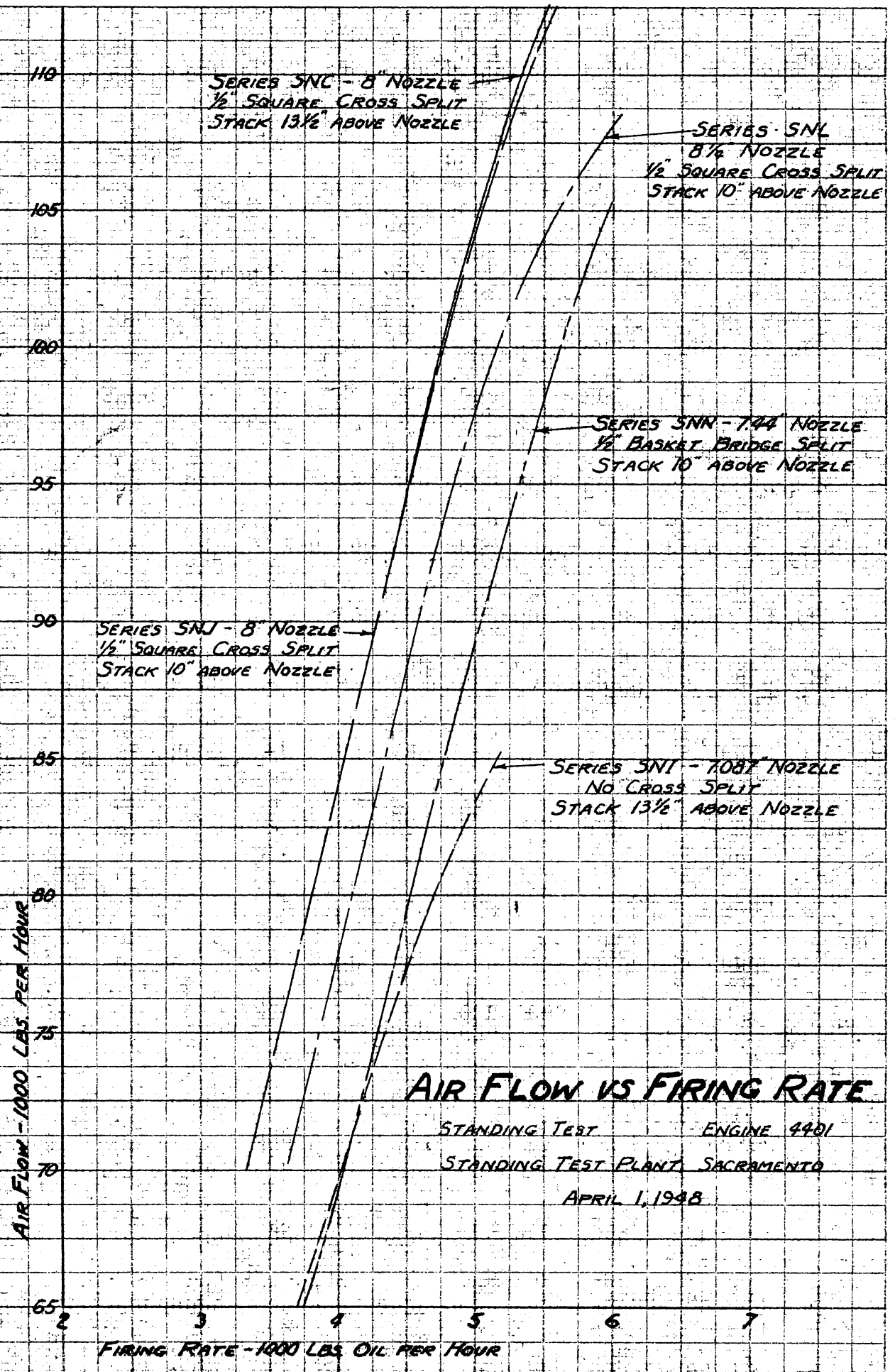


FIG. 2-31

ST-158

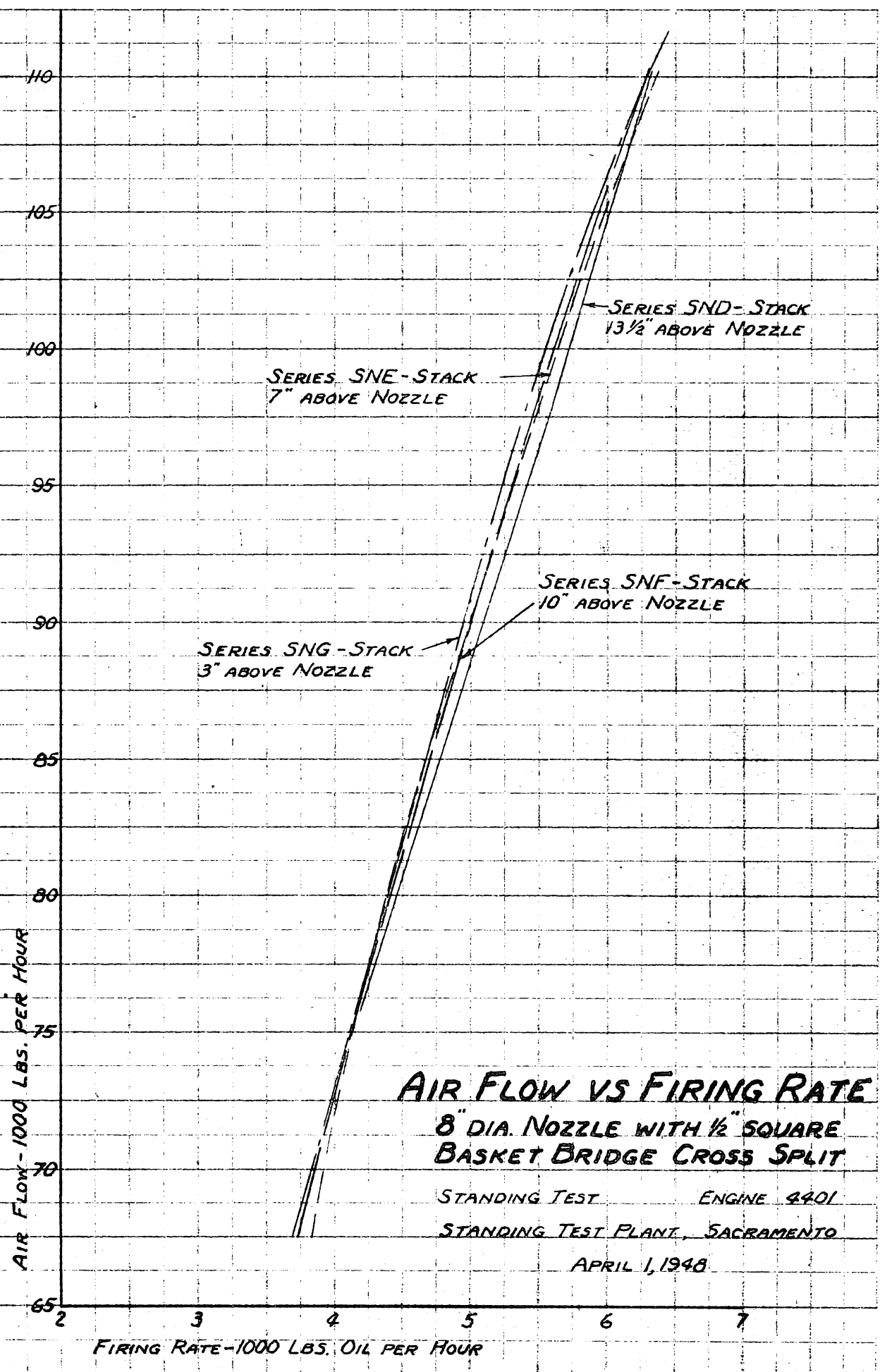
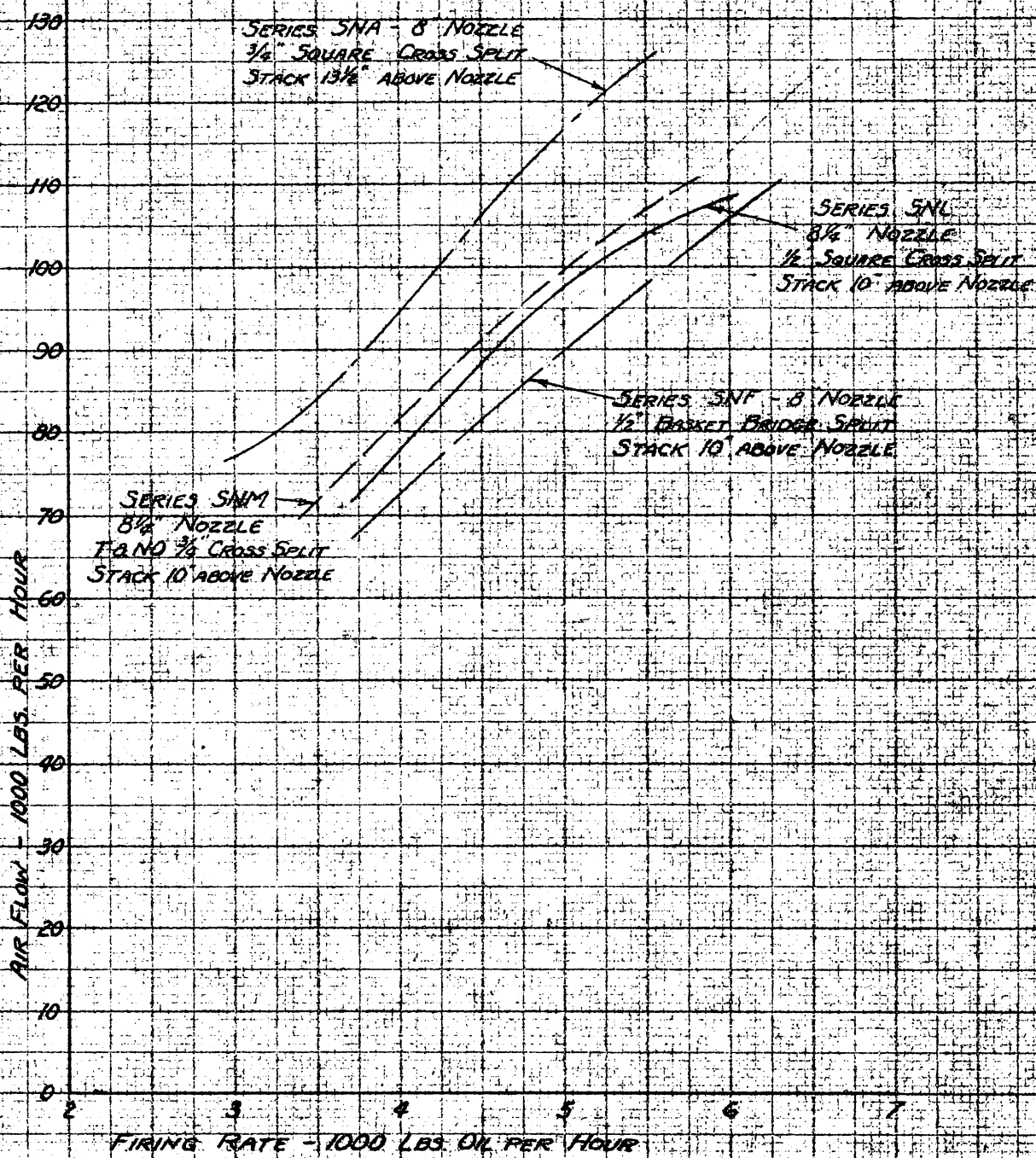


FIG. 2-32

51-159



AIR FLOW VS FIRING RATE

STANDING TEST

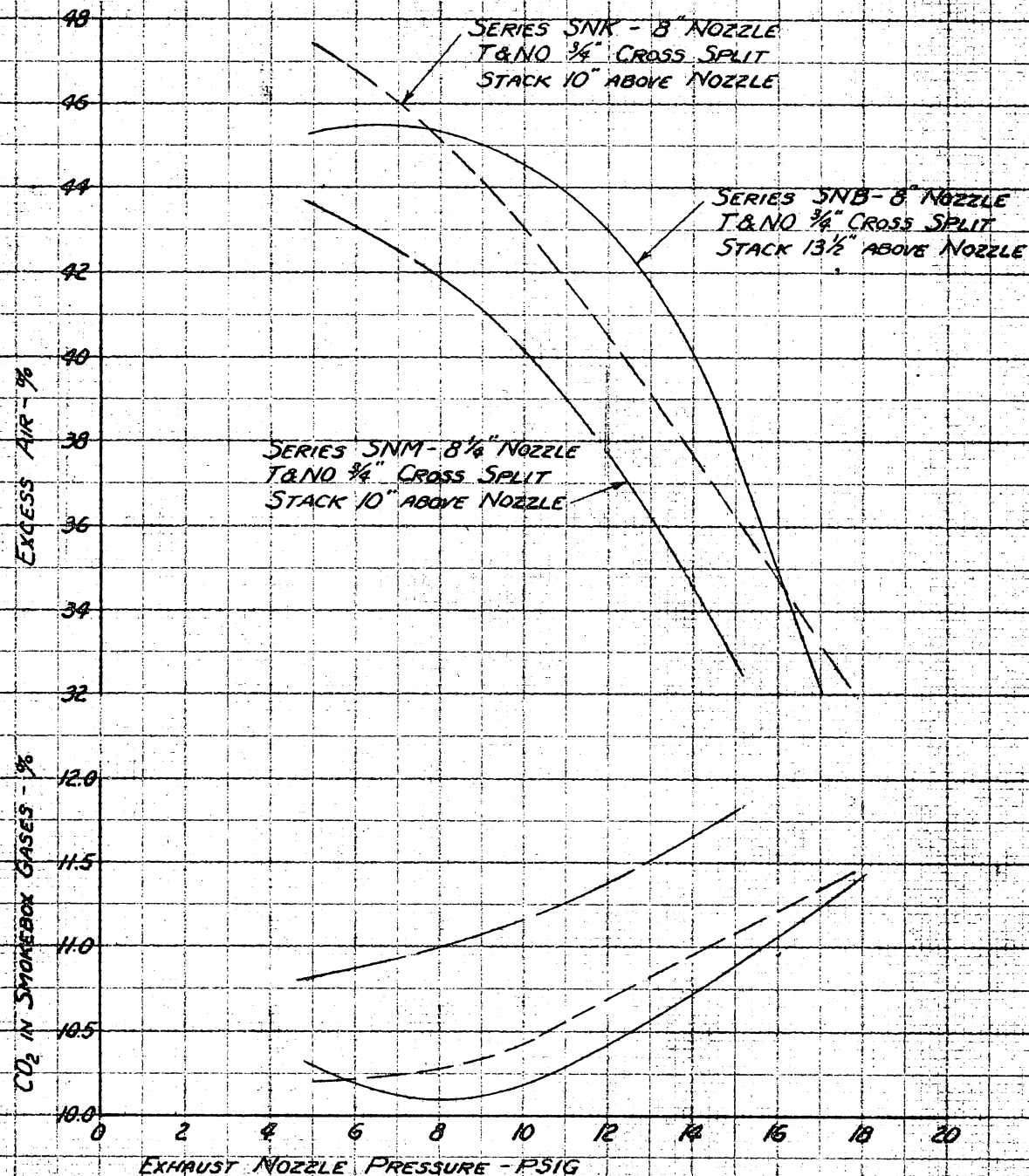
ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-33

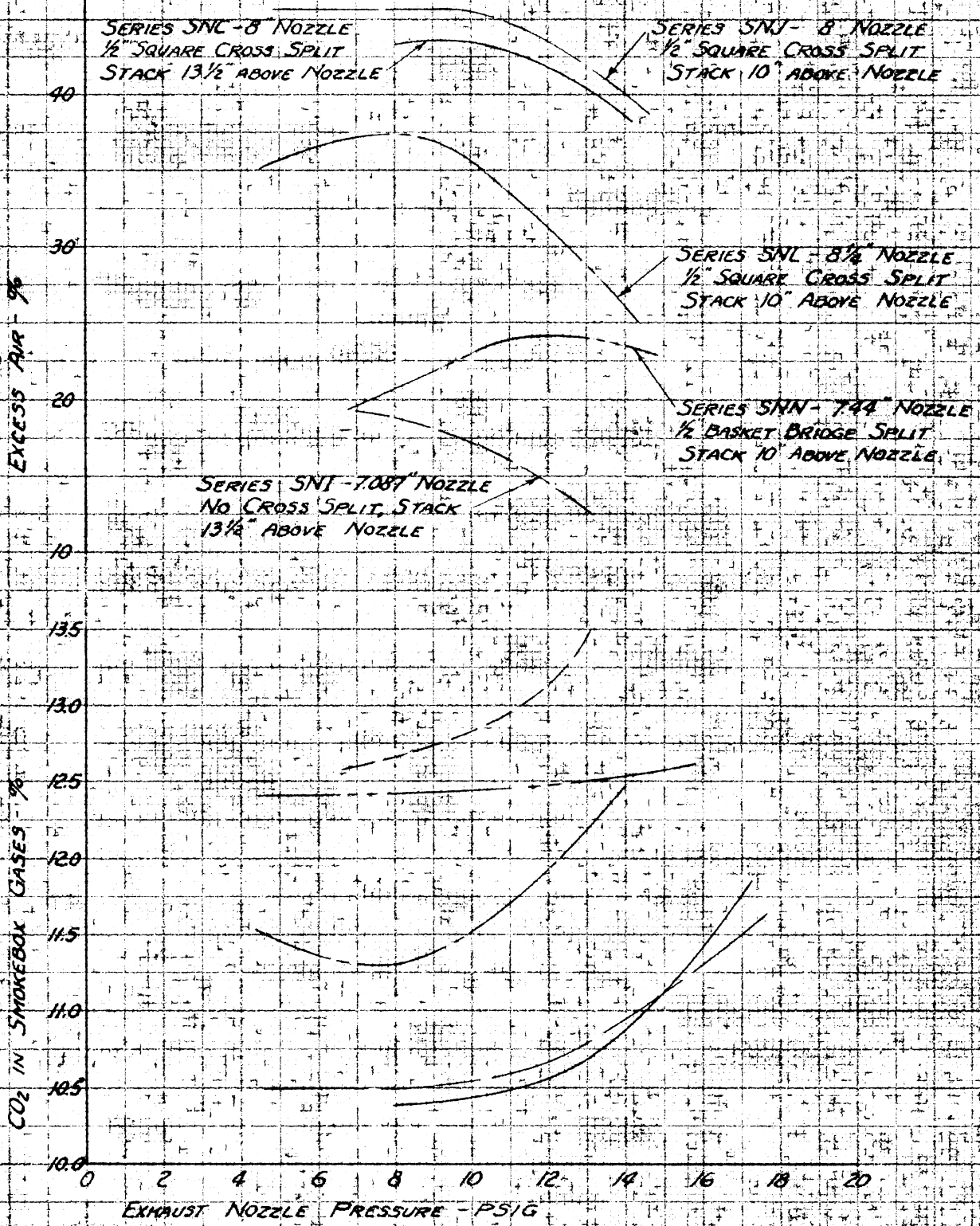
ST-160



CO₂ & EXCESS AIR VS EXHAUST NOZZLE PRESSURE

STANDING TEST ENGINE 4401

ST-161

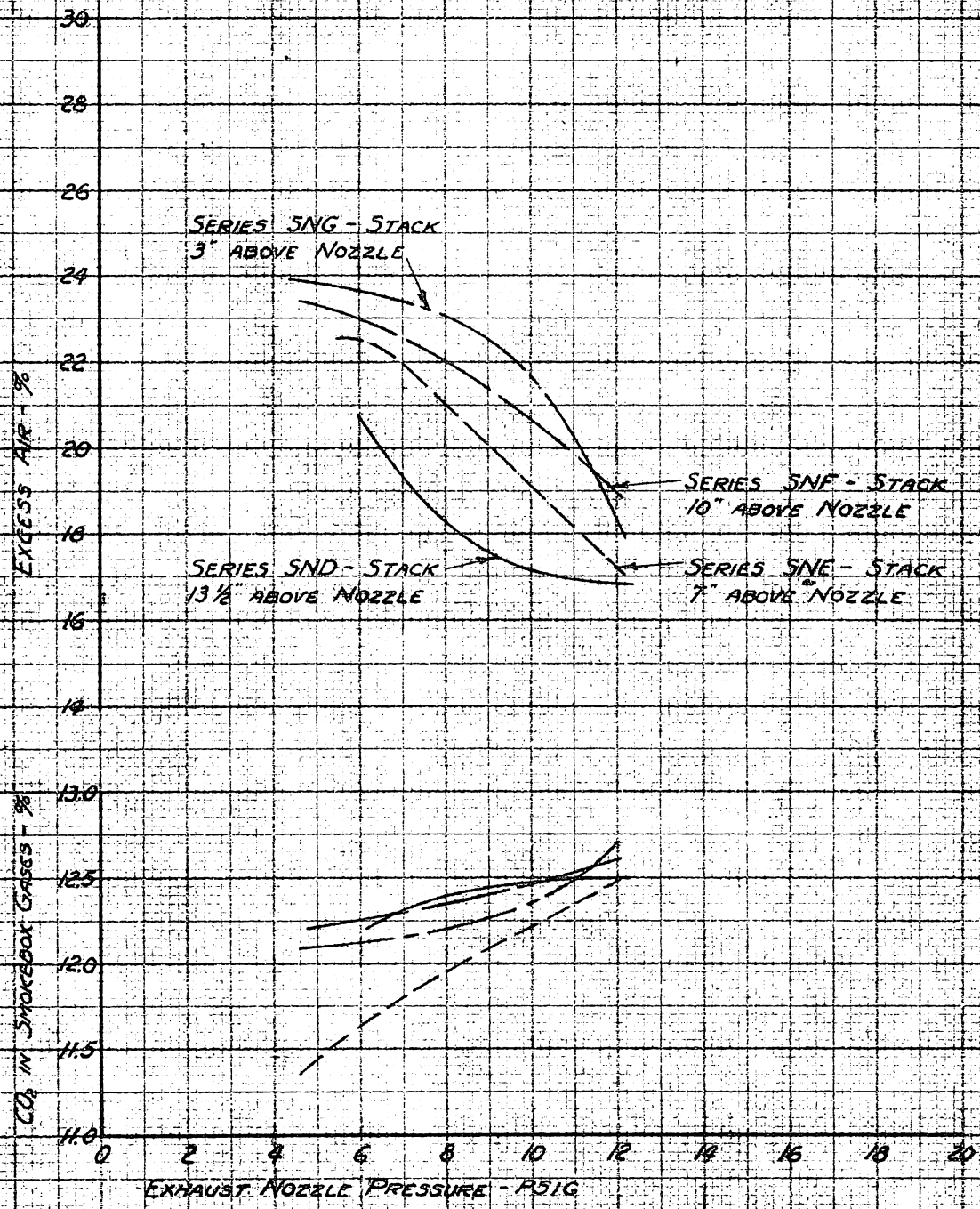


CO₂ & EXCESS AIR VS EXHAUST NOZZLE PRESSURE

STANDING TEST ENGINE 4401

FIG. 2-35

ST-162 A



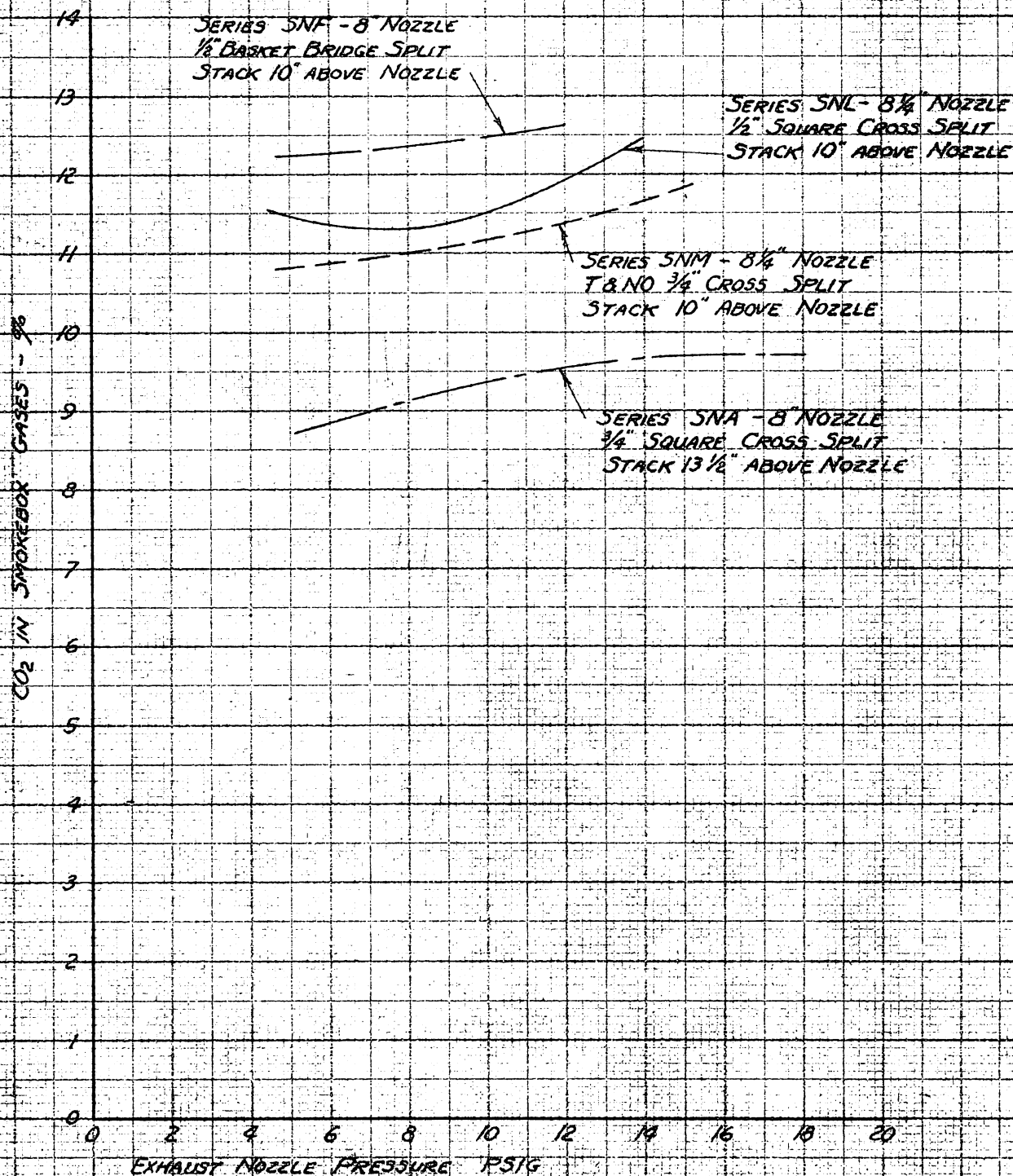
CO₂ & EXCESS AIR VS EXHAUST NOZZLE PRESSURE
 8" DIA. NOZZLE WITH 1/2" SQUARE
 BASKET BRIDGE CROSS SPLIT

STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-36



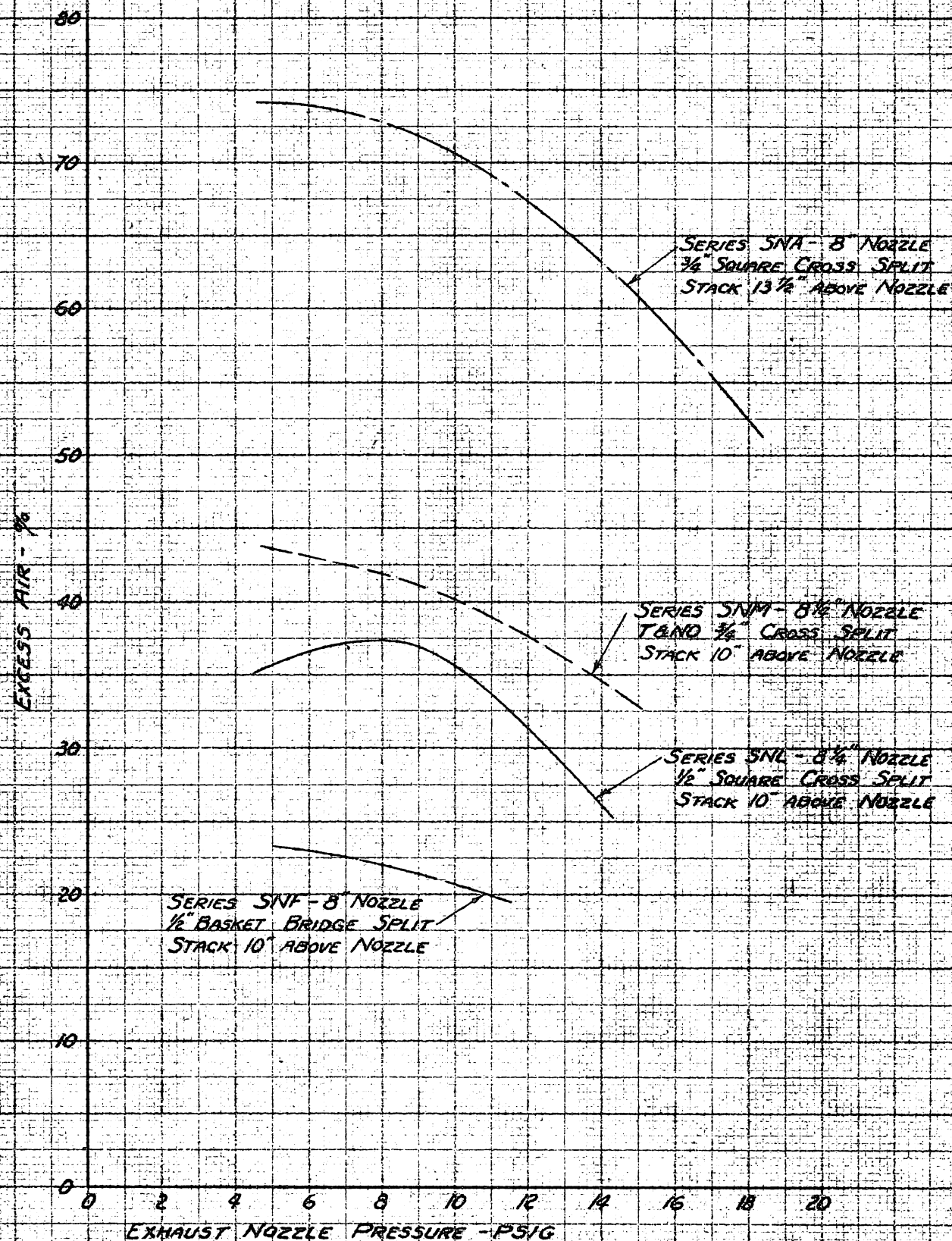
CO₂ VS EXHAUST NOZZLE PRESSURE

STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

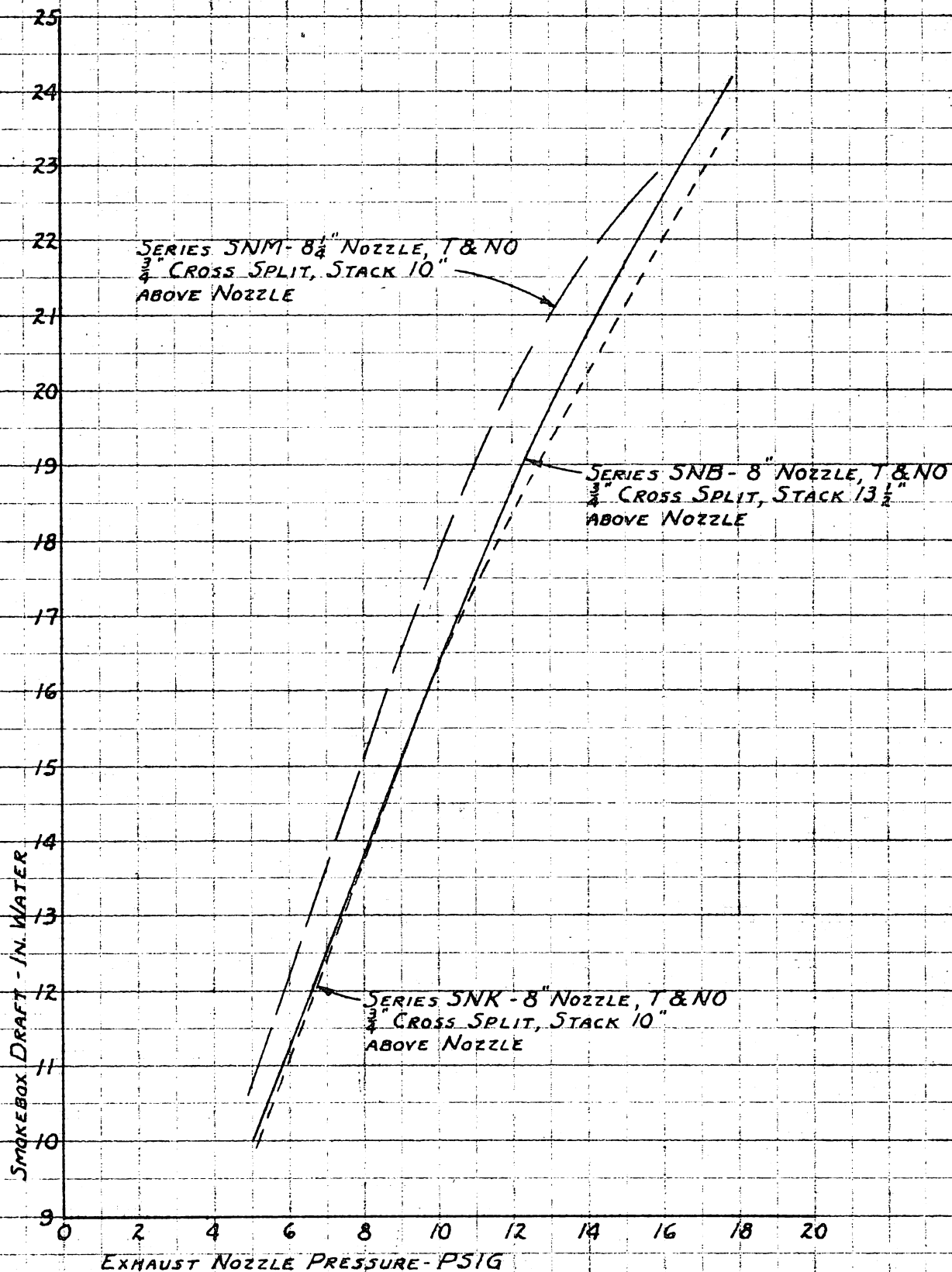
FIG. 2-37



EXCESS AIR VS EXHAUST NOZZLE PRESSURE

STANDING TEST ENGINE 9901

ST-165



SMOKEBOX DRAFT VS EXHAUST NOZZLE PRESSURE

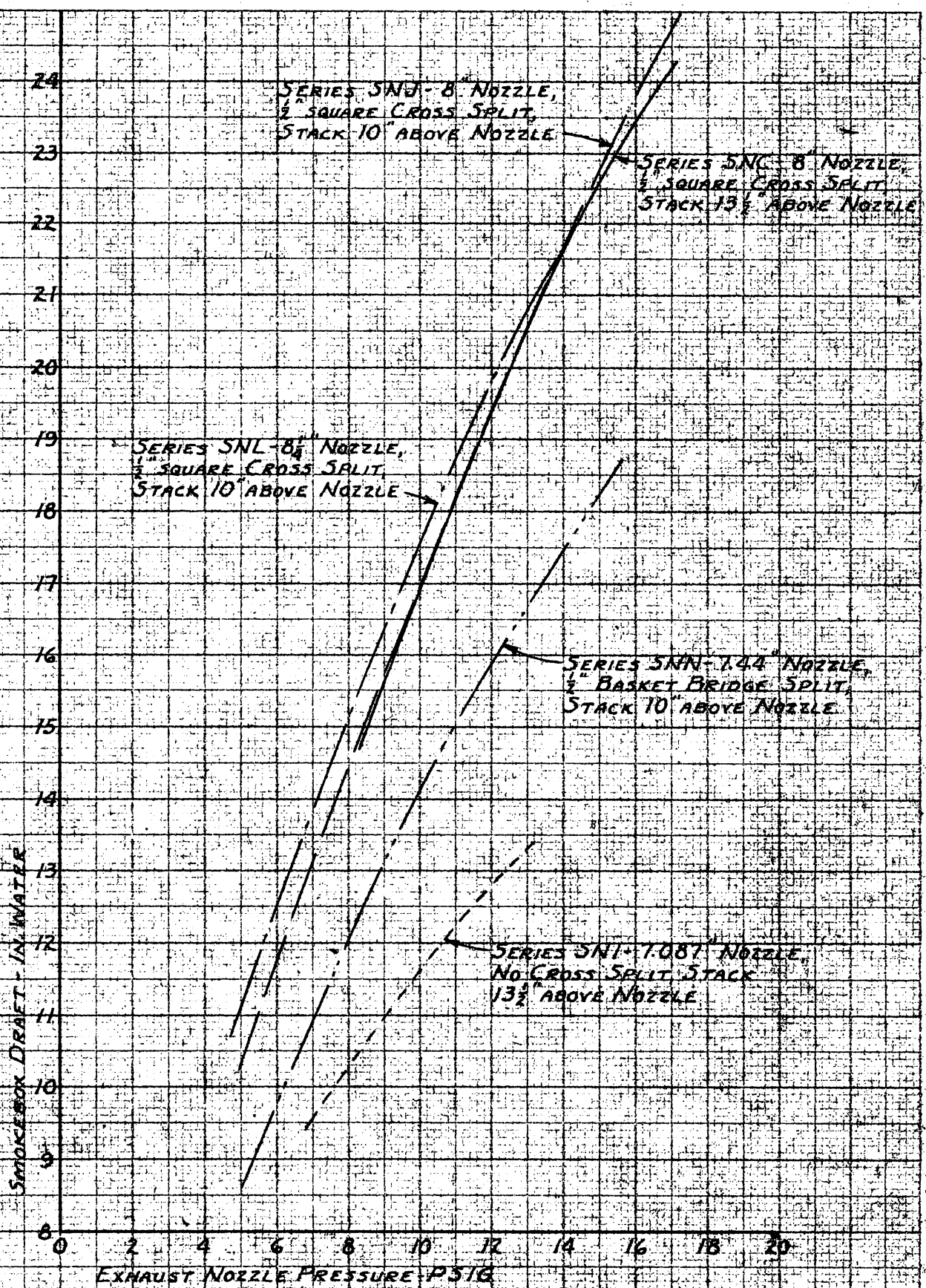
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-39

SI-166



SMOKEBOX DRAFT VS EXHAUST NOZZLE PRESSURE

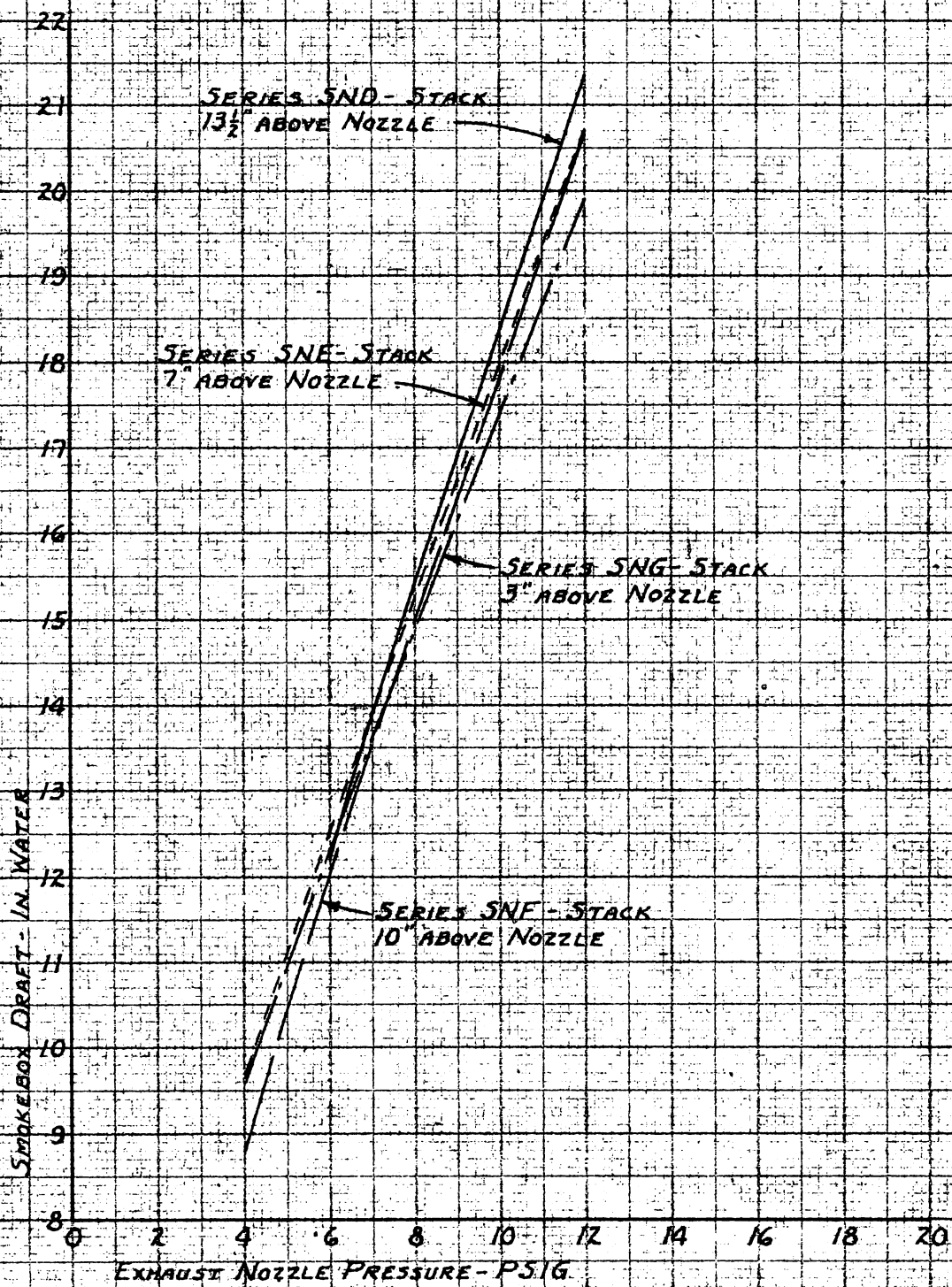
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-40

ST-167



SMOKEBOX DRAFT VS EXHAUST NOZZLE PRESSURE

8" DIA NOZZLE WITH 1/2" SQUARE BASKET BRIDGE CROSS SPLIT

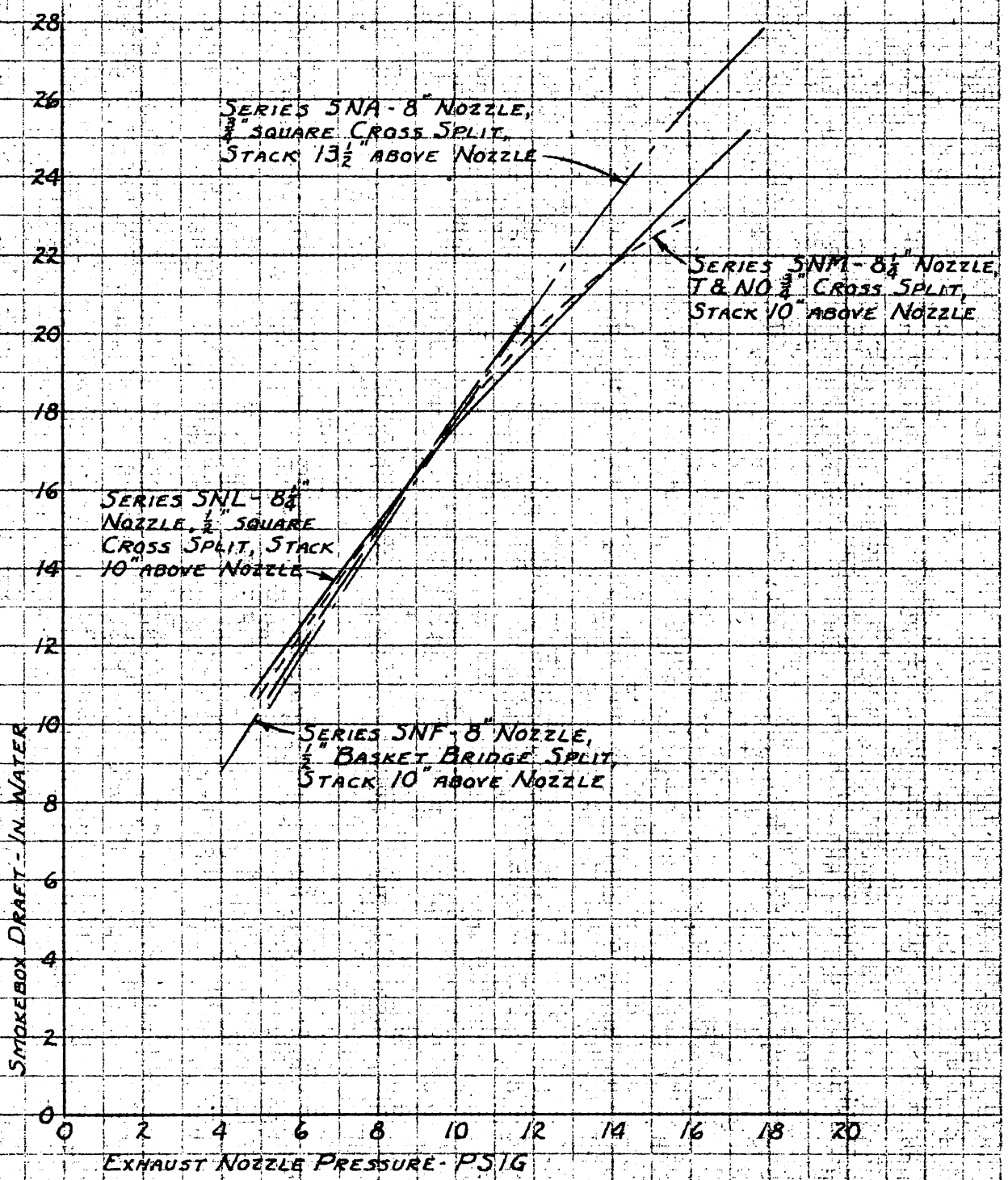
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-41

ST-168



SMOKEBOX DRAFT VS EXHAUST NOZZLE PRESSURE

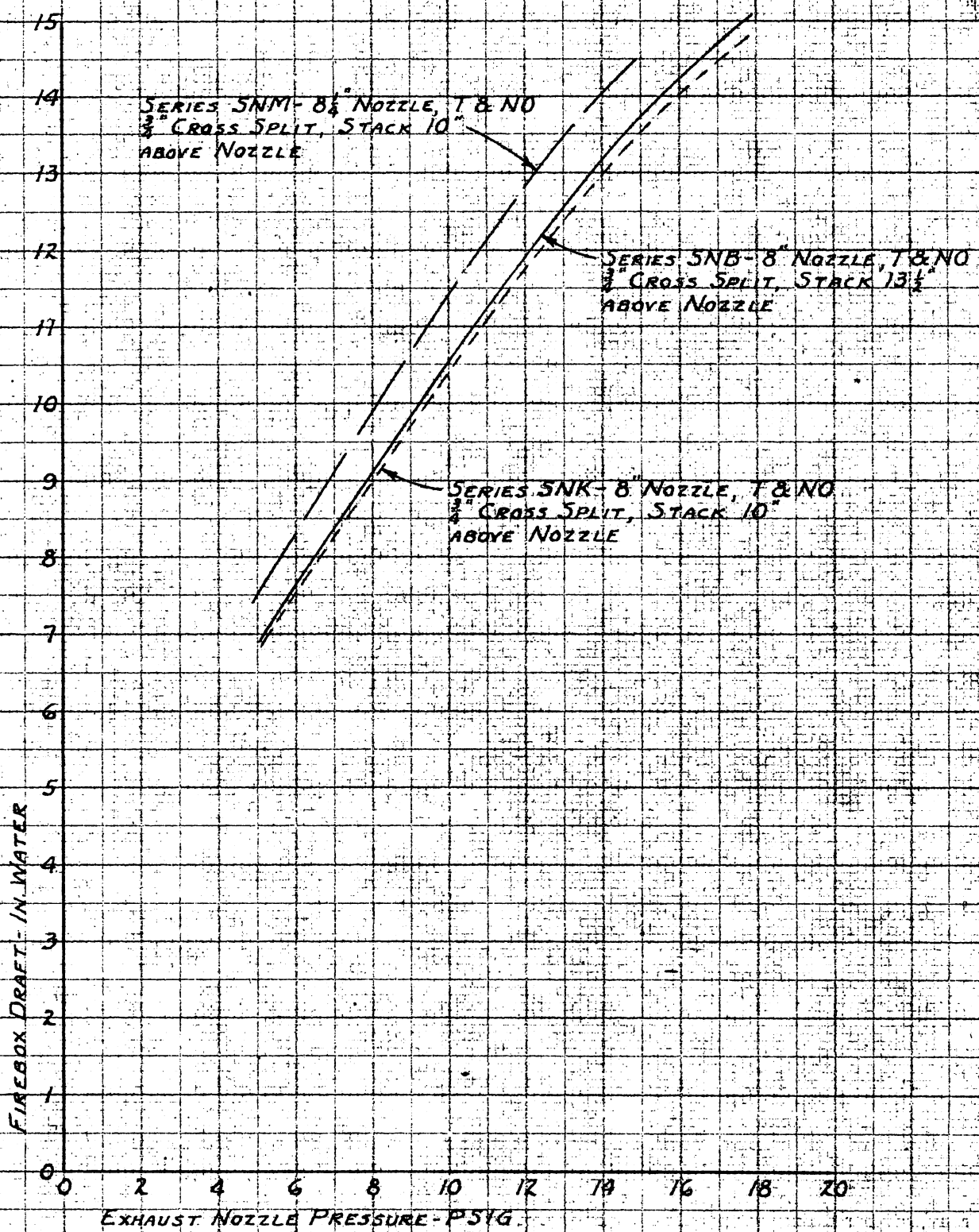
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-42

ST-169



FIREBOX DRAFT VS EXHAUST NOZZLE PRESSURE

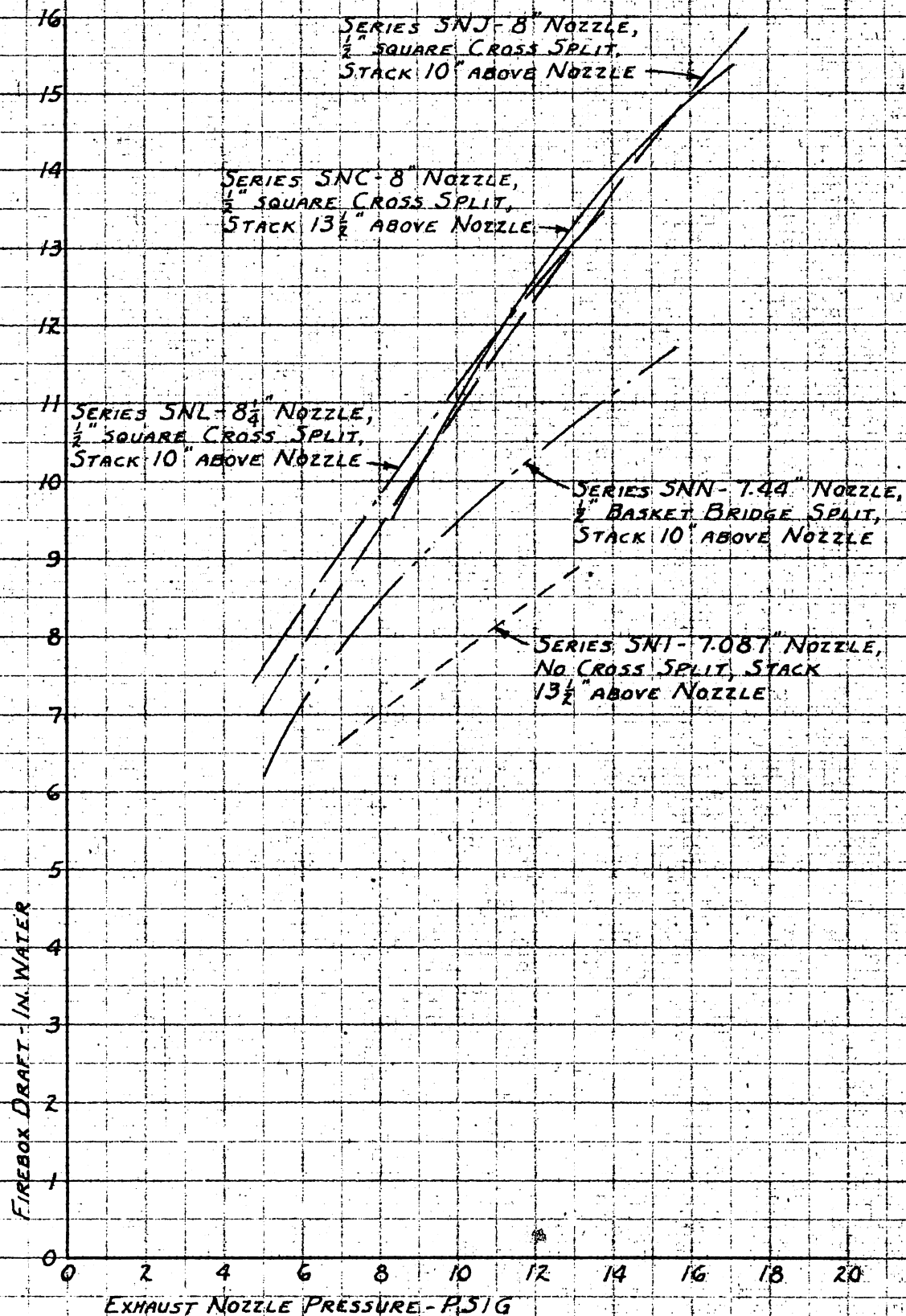
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-43

ST-170



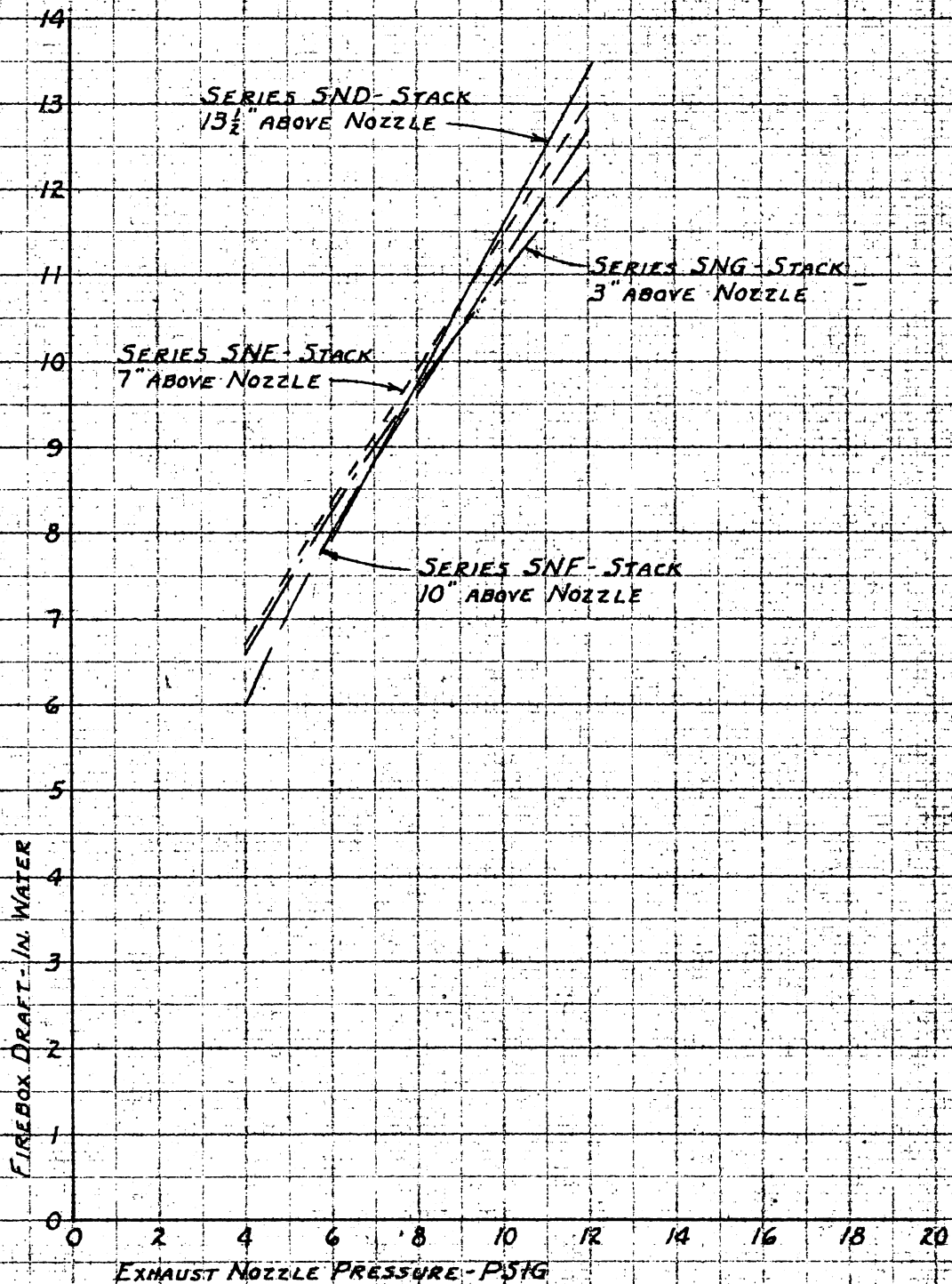
FIREBOX DRAFT VS EXHAUST NOZZLE PRESSURE

STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-44



FIREBOX DRAFT VS EXHAUST NOZZLE PRESSURE

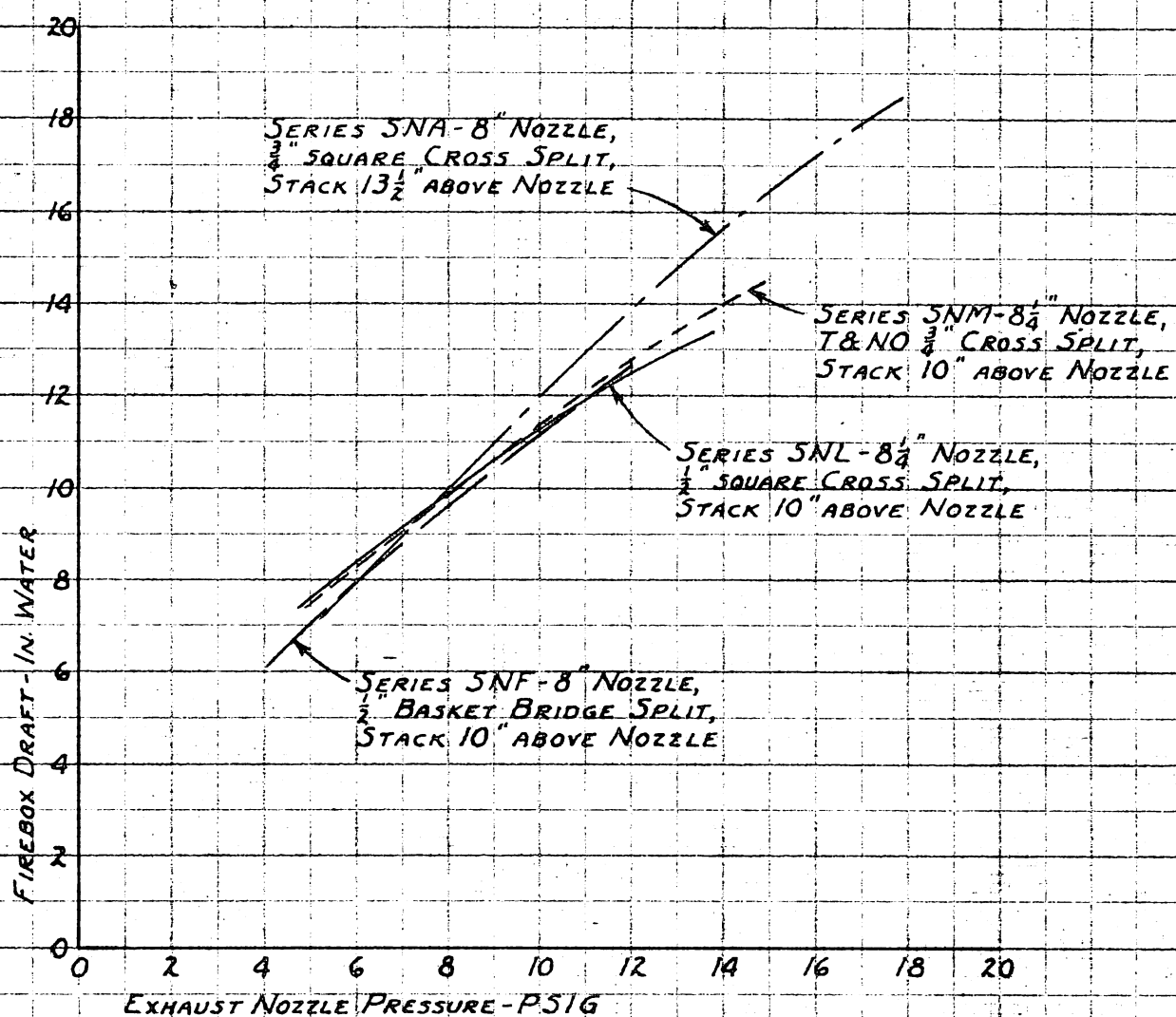
8" DIA. NOZZLE WITH 1/2" SQUARE
BASKET BRIDGE CROSS SPLIT

STANDING TEST ENGINE 440P

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-45



FIREBOX DRAFT VS EXHAUST NOZZLE PRESSURE

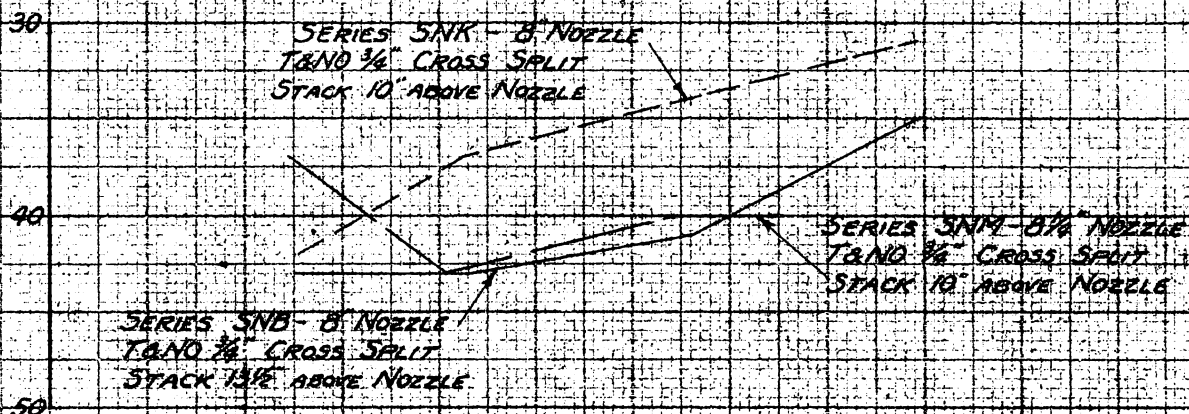
STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

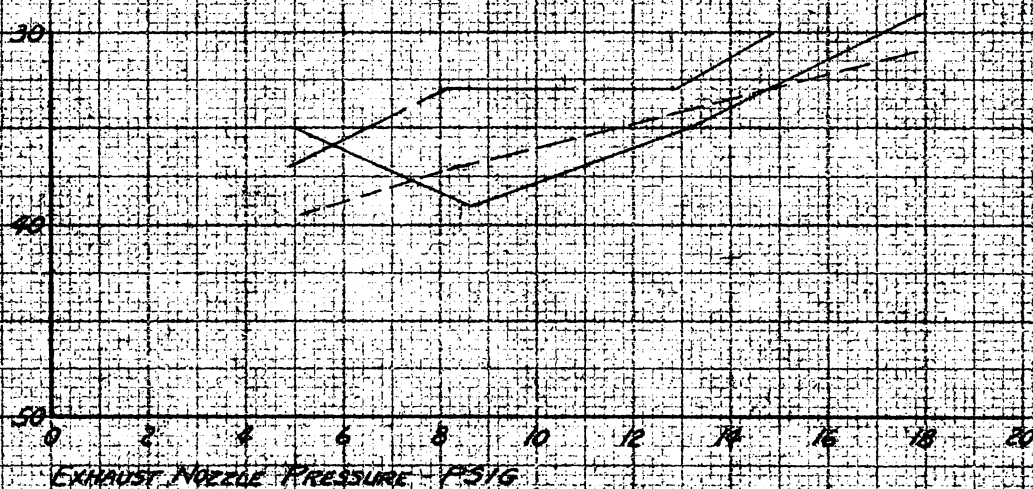
APRIL 1, 1948

FIG. 2-46

IMPINGEMENT OF EXHAUST STEAM
JET AT SIDE OF STACK
INCHES FROM TOP OF STACK



IMPINGEMENT OF EXHAUST STEAM
JET AT BACK OF STACK
INCHES FROM TOP OF STACK



STACK IMPINGEMENT VS EXHAUST NOZZLE PRESSURE

STANDING TEST

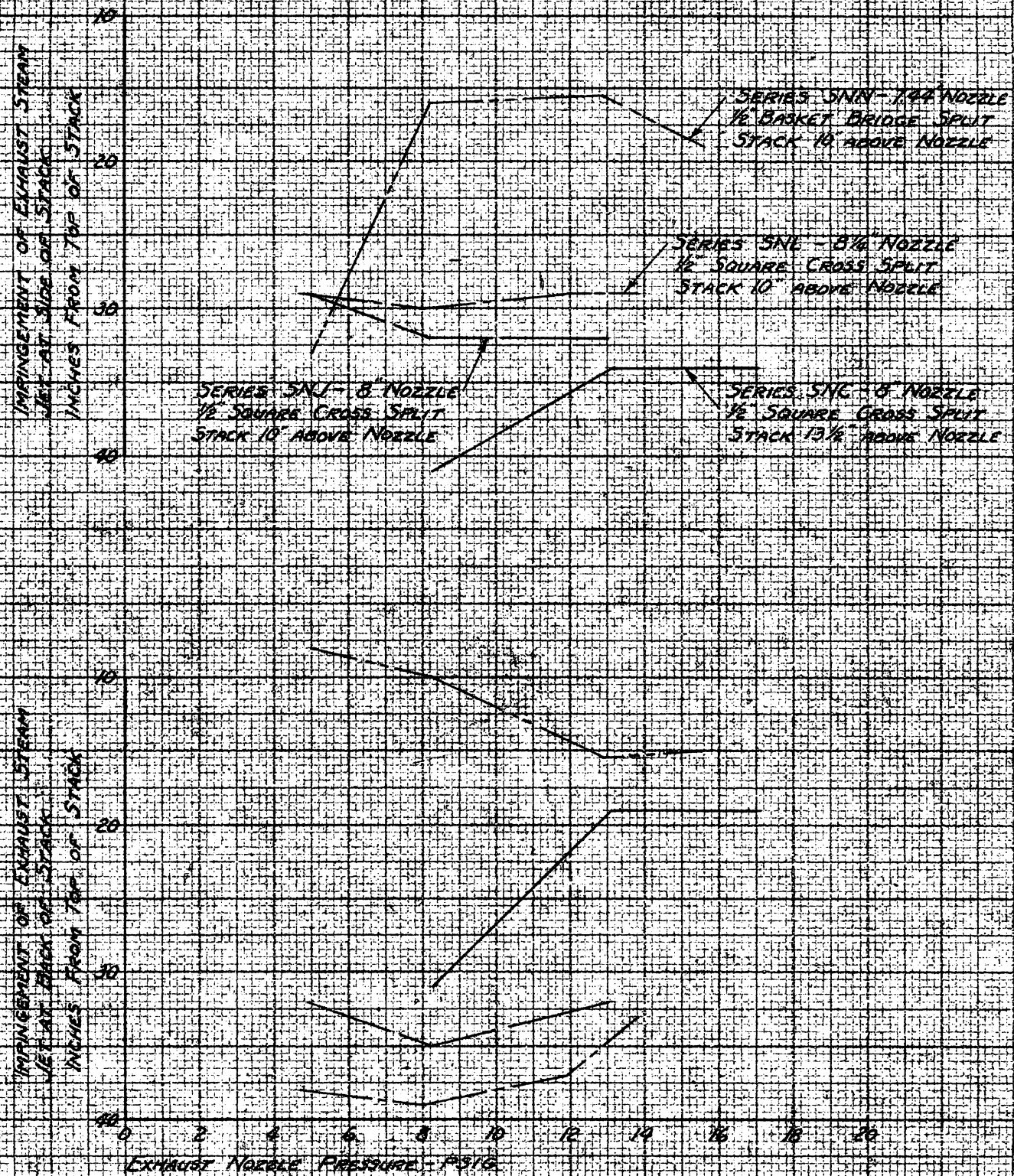
ENGINE - 9401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

Fig. 2-47

51-174



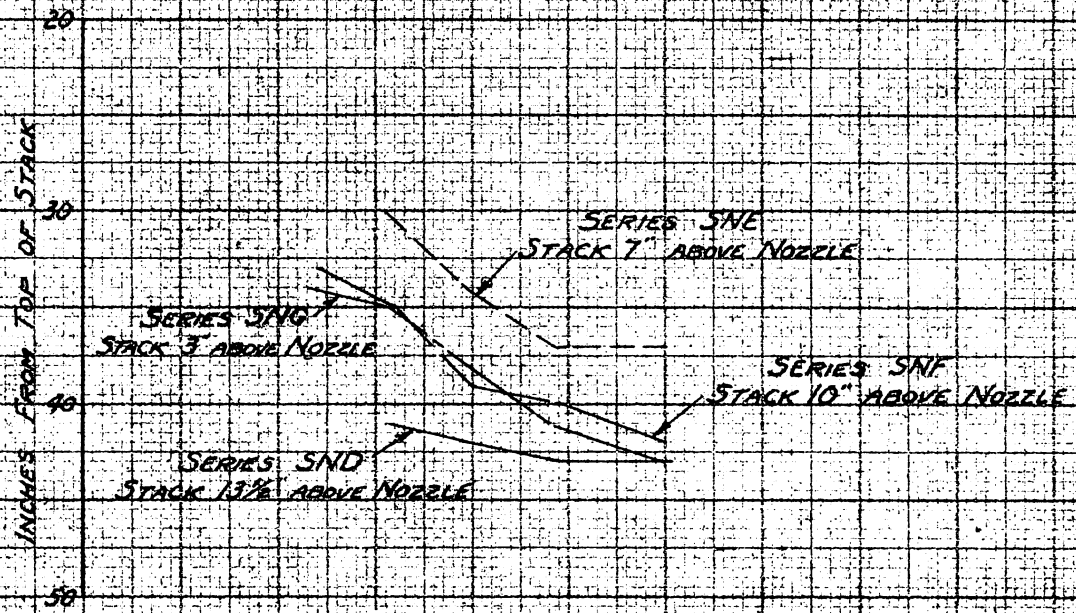
STACK IMPINGEMENT VS EXHAUST NOZZLE PRESSURE

STANDING TEST ENGINE 2201

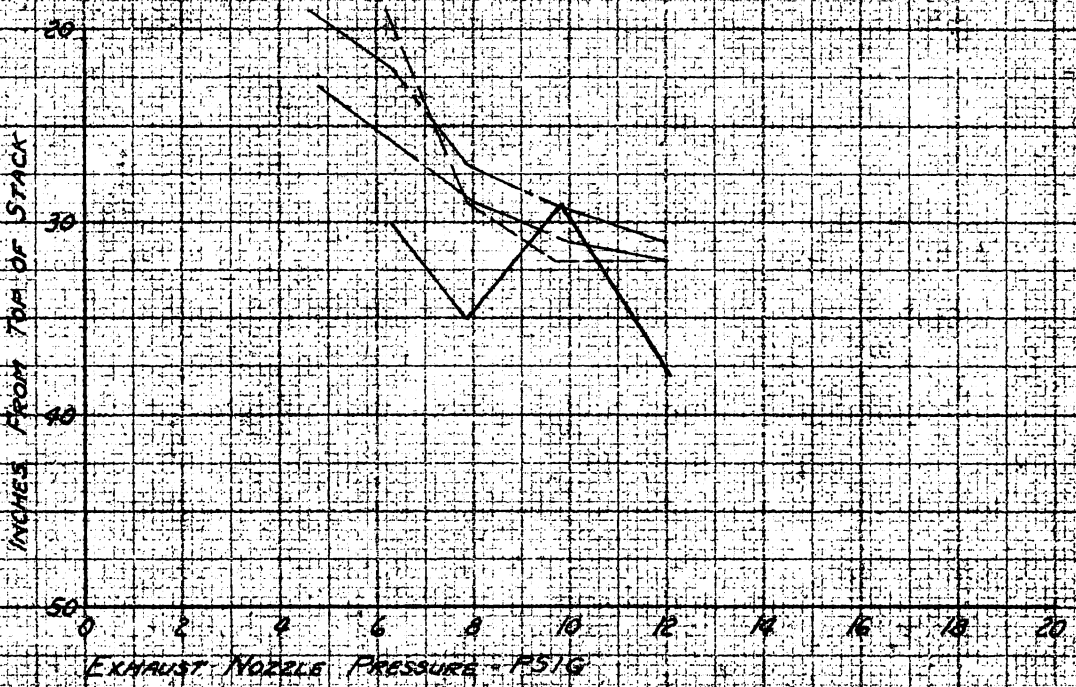
FIG. 2-48

ST-175

IMPINGEMENT OF EXHAUST STEAM
JET AT SIDE OF STACK



IMPINGEMENT OF EXHAUST STEAM
JET AT BACK OF STACK



STACK IMPINGEMENT VS EXHAUST NOZZLE PRESSURE 8" NOZZLE - 1/2" BASKET BRIDGE SPLIT

STANDING TEST

ENGINE 9901

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-49

ST-176

IMPINGEMENT OF EXHAUST STEAM
JET AT SIDE OF STACK
INCHES FROM TOP OF STACK

10

20

30

40

50

60

70

80

90

100

SERIES SNL - 8 1/4 NOZZLE
1/8 SQUARE CROSS SPLIT
STACK 10" ABOVE NOZZLE

SERIES SNF - 8 NOZZLE
1/8 BASKET BRIDGE SPLIT
STACK 10" ABOVE NOZZLE

SERIES SNM - 8 1/4 NOZZLE
1/8 AND 3/8 CROSS SPLIT
STACK 10" ABOVE NOZZLE

IMPINGEMENT OF EXHAUST STEAM
JET AT BACK OF STACK
INCHES FROM TOP OF STACK

10

20

30

40

50

STACK IMPINGEMENT VS EXHAUST NOZZLE PRESSURE

STANDING TEST

ENGINE 4901

EXHAUST NOZZLE PRESSURE PSIG

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-50

DATA USED IN PLOTTING FIREBOX AND BOILER SHEET

Temperature Position No.	FIREBOX AND BOILER SHEET TEMPERATURE - OF. (AVERAGE)								Exhaust Nozzle Pressure PSIG
	<u>1</u>	<u>2</u>	<u>3</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	
Series SND 13½" Stack Height	406.5	433.1	419.4	409.6	409.7	407.5	397.4	399.5	6.30
	402.3	424.1	414.4	409.9	407.2	396.2	397.3	401.8	7.79
	400.8	437.5	411.8	409.9	408.3	395.8	397.4	400.7	7.89
	407.0	433.0	421.1	411.9	409.6	397.6	398.0	402.1	9.80
	406.0	428.8	416.7	411.2	409.2	397.9	397.4	402.3	12.06
Series SNE 7" Stack Height	406.6	433.8	422.8	411.1	409.0	397.8	400.0	400.1	4.63
	404.6	425.8	416.4	411.8	410.0	398.6	400.1	404.4	6.23
	406.7	432.9	423.8	410.2	407.7	397.8	397.9	401.5	7.88
	403.4	424.1	413.1	411.7	409.7	398.1	397.8	402.4	12.04
Series SNF 10" Stack Height	406.1	427.5	416.3	410.1	407.9	397.0	398.0	398.0	4.76
	405.1	427.9	415.1	409.7	407.4	396.8	397.2	398.2	6.37
	404.6	424.4	413.6	409.9	407.1	397.0	396.9	399.8	7.95
	404.4	423.9	413.8	410.3	407.7	397.6	397.0	400.7	9.90
	404.0	424.8	413.6	411.3	408.8	398.0	397.2	401.7	11.98
Series SNG 3" Stack Height	405.9	432.0	423.2	409.7	408.0	397.5	398.8	398.5	4.60
	405.3	432.3	423.0	410.0	408.0	397.2	397.8	399.4	6.34
	404.3	430.8	422.2	410.5	408.0	397.3	397.3	400.5	7.88
	403.7	425.1	418.3	410.8	408.0	397.7	397.7	401.8	9.58
	402.9	423.5	414.2	411.3	408.3	397.3	397.1	402.2	11.96

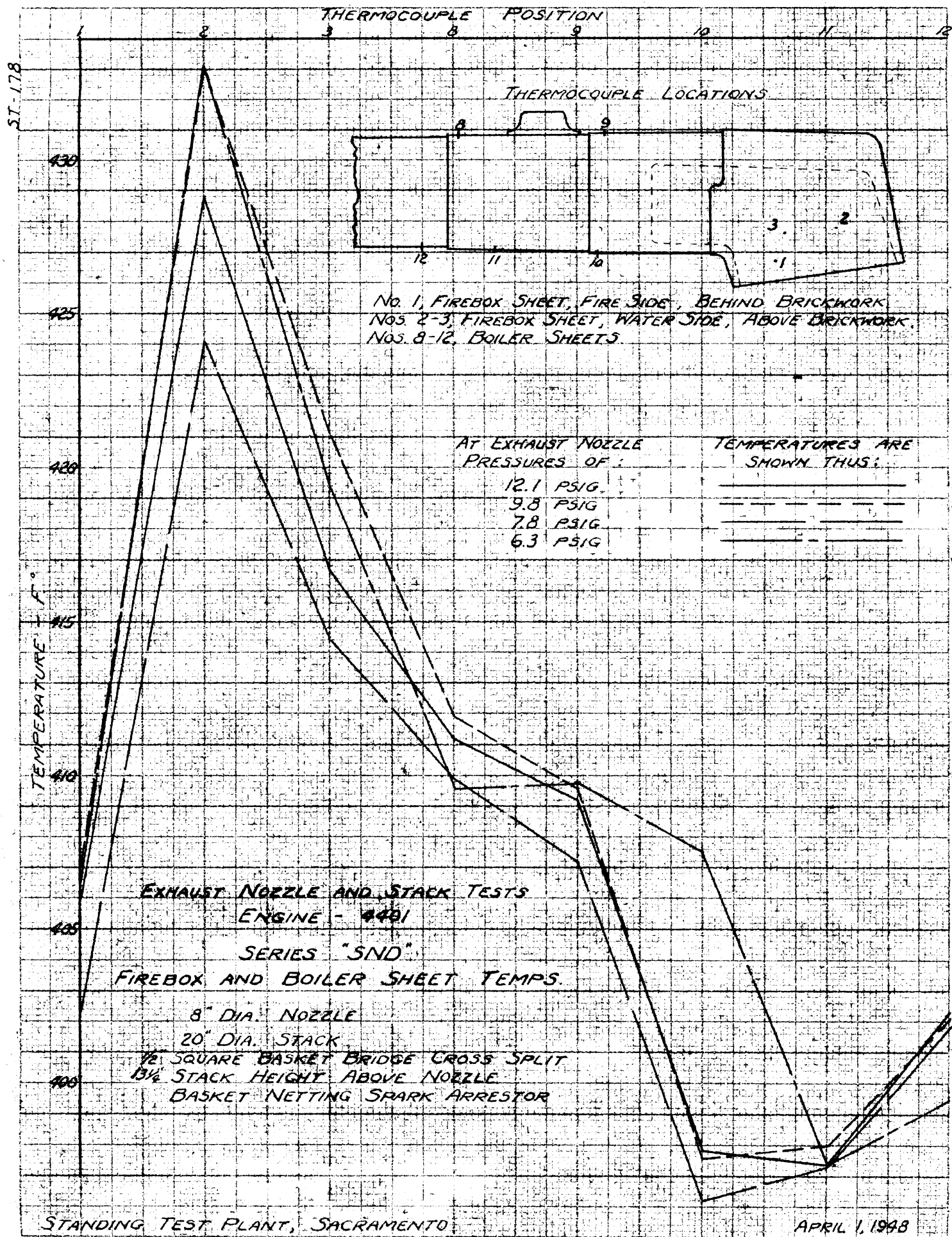
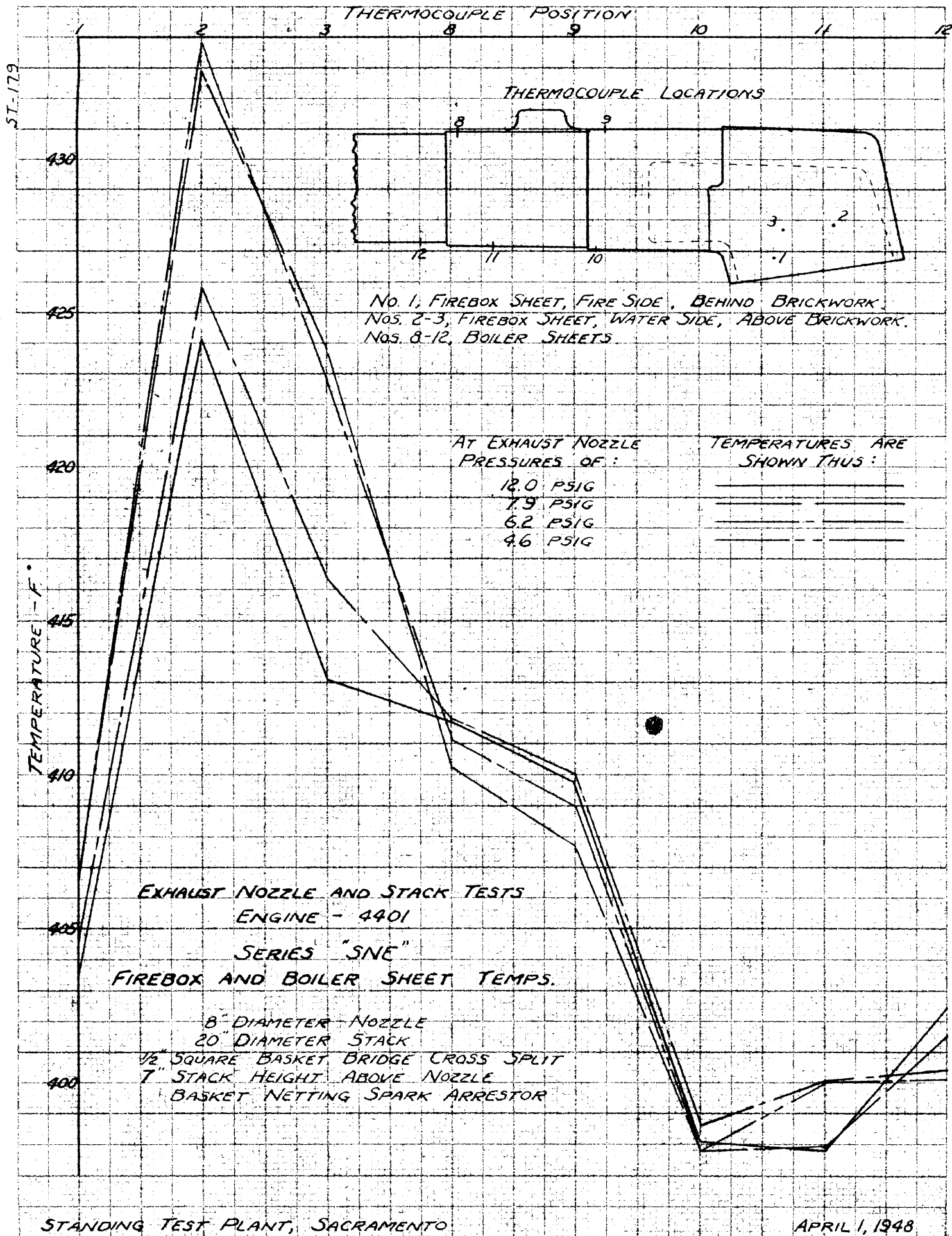
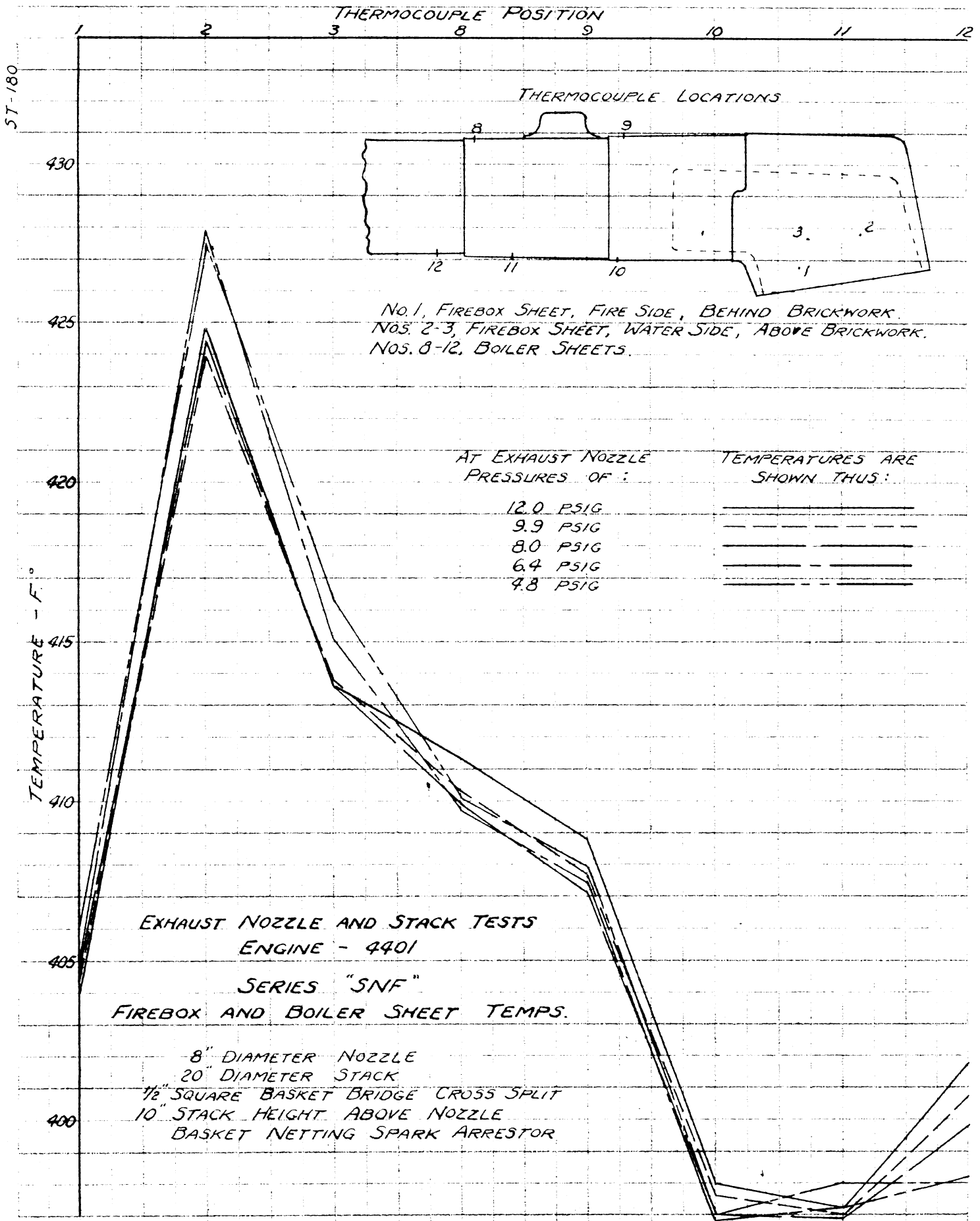


Fig. 2-52





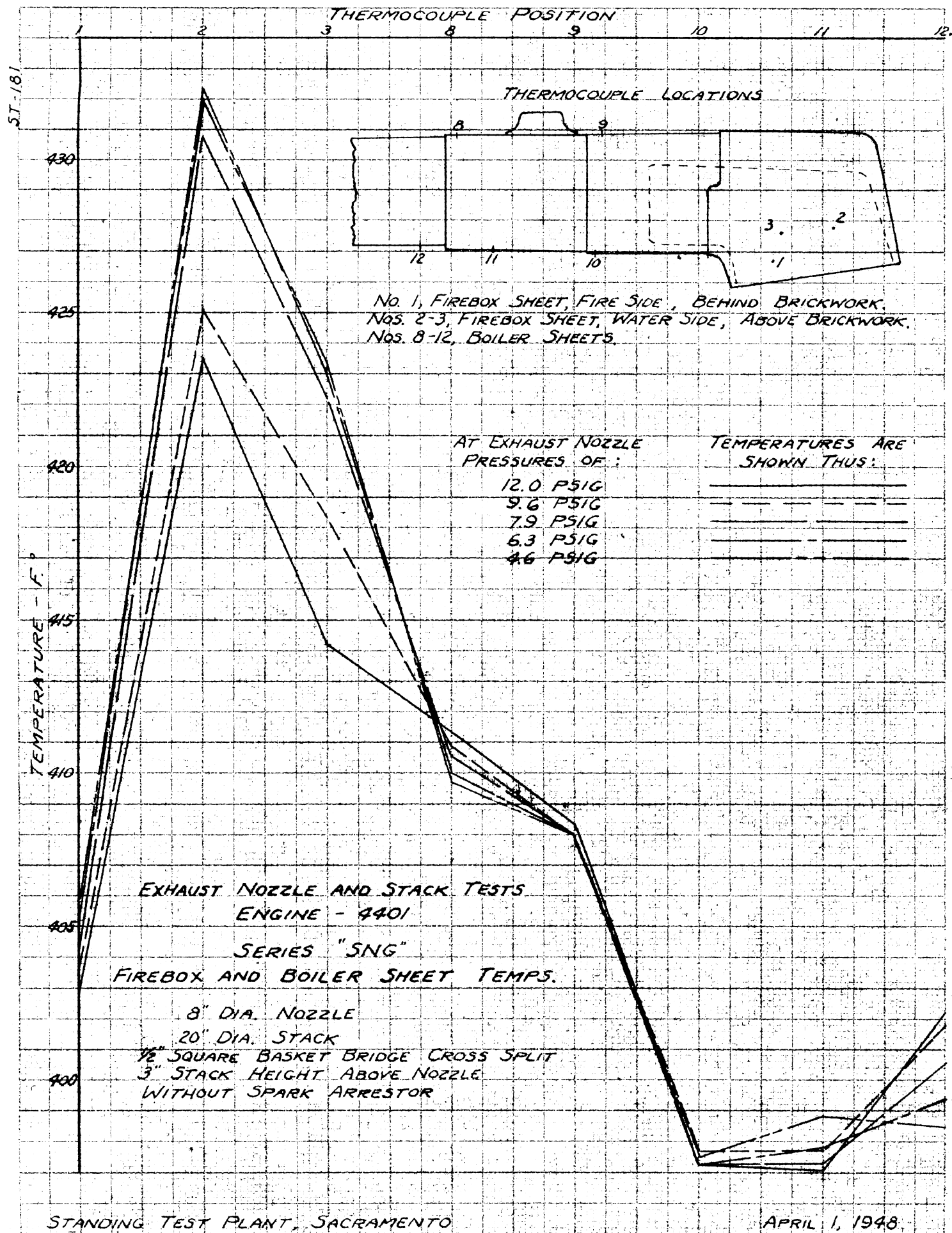


FIG. 2-55



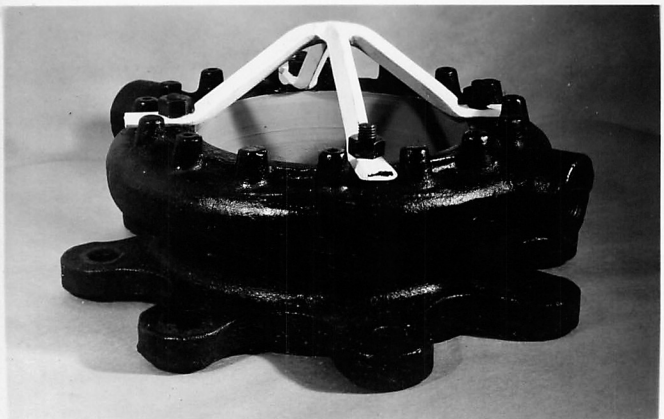
Existing Standard 3/4" square bar cross split for GS Class Locomotives on Southern Pacific Lines. Used in Test Series SNA.



Existing Standard 3/4" wide cross split for GS Class Locomotives on T&NO Lines. Used in Test Series SNB, SNK & SNM.



Existing Standard 1/2" square bar cross split for Locomotives other than GS Class on Southern Pacific Lines. Used in Test Series SNC, SNJ & SNL.



Experimental design of pyramid shaped basket bridge of 1/2" square bar. Used in Test Series SND, SNE, SNF, SNG & SNN.



View down into stack from top rear edge, not vertical, showing light colored, steam blasted areas where the four separate exhaust steam jets keep soot from accumulating. Note that areas from front jet (top) and side jets, merge a short distance up the stack while between rear jet (bottom) and side jets a wide separating strip of dark unscoured area exists, all indicating a forward displacement of the steam jets.

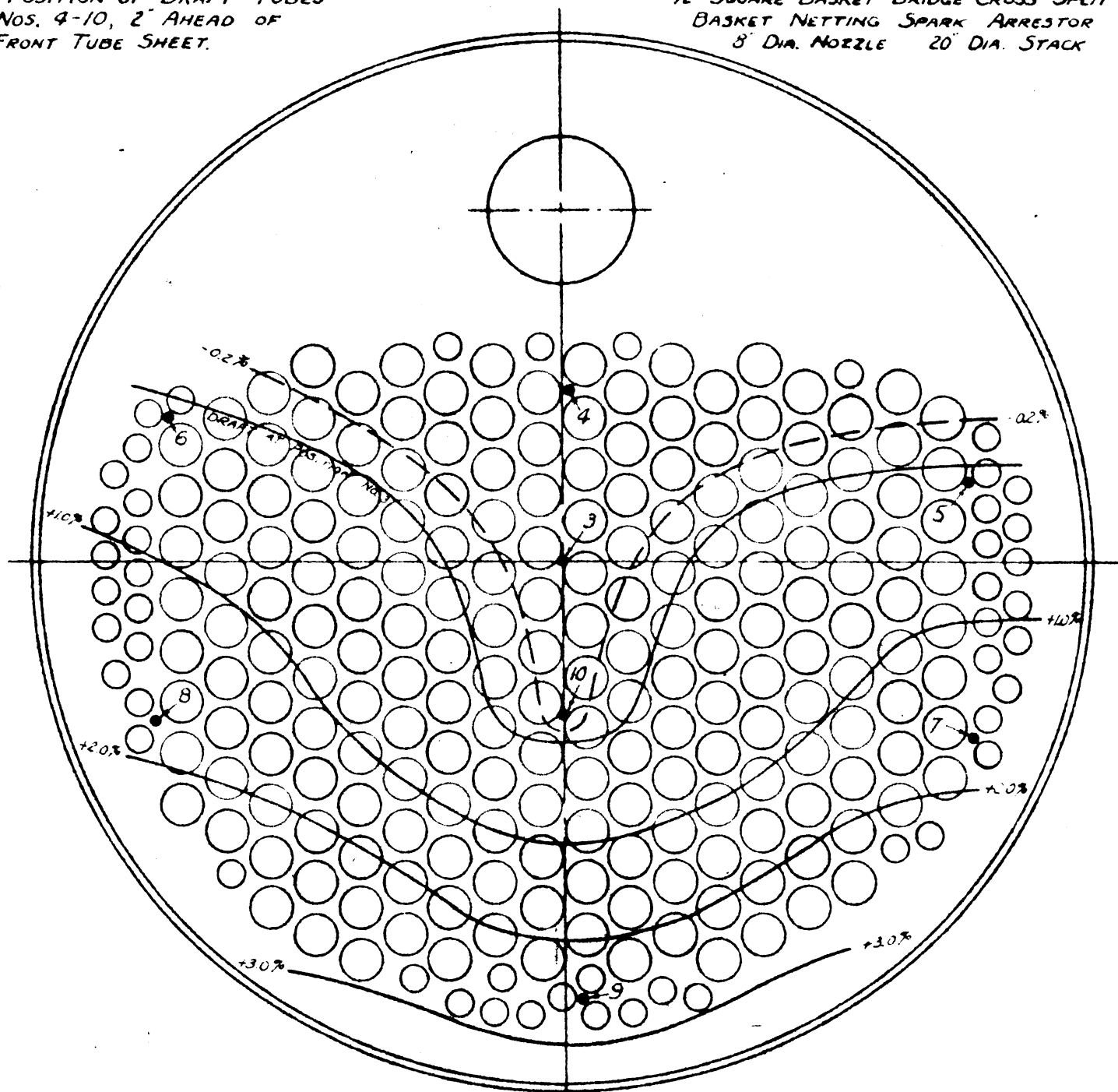
DATA USED IN PLOTTING "PROBABLE LOCATION OF DRAFT ISOBARS ON FRONT TUBE SHEET"

DRAFT POSITION	DRAFT - INCHES OF WATER								Exhaust Nozzle Pressure PSIG
	3	4	5	6	7	8	9	10	
Series SND 13½" Stack Height	12.53	12.58	12.61	12.58	12.72	12.72	12.83	12.60	6.30
	15.13	15.08	15.14	15.18	15.41	15.42	15.51	15.08	7.79
	15.11	14.89	15.09	15.13	15.34	15.35	15.52	15.00	7.89
	17.76	17.44	17.78	17.84	18.07	18.09	18.28	17.71	9.80
	21.32	21.09	21.31	21.36	21.66	21.68	21.87	21.19	12.06
Average	16.370	16.216	16.386	16.418	16.640	16.652	16.802	16.316	8.77
% Increment Over Position 3:	0.00	-0.941	+0.098	+0.293	+1.65	+1.72	+2.64	-0.330	
Series SNE 7" Stack Height	10.61	10.65	10.67	10.73	10.85	10.82	10.77	10.63	4.63
	12.48	12.42	12.47	12.60	12.78	12.73	12.65	12.47	6.23
	15.02	14.94	15.07	15.12	15.22	15.25	15.17	15.02	7.88
	17.18	16.96	17.24	17.25	17.46	17.48	17.27	17.12	9.73
	20.60	20.31	20.70	20.73	20.99	21.02	20.77	20.55	12.04
Average	15.178	15.056	15.230	15.286	15.460	15.460	15.326	15.158	8.10
% Increment Over Position 3:	0.00	-0.804	+0.343	+0.712	+1.86	+1.86	+0.976	-0.132	
Series SNF 10" Stack Height	10.33	10.36	10.45	10.40	10.51	10.47	10.35	10.26	4.76
	12.88	12.86	12.90	12.97	13.12	13.11	12.95	12.83	6.37
	14.51	14.45	14.56	14.61	14.80	14.75	14.54	14.45	7.95
	17.34	17.12	17.35	17.44	17.69	17.63	17.39	17.12	9.90
	20.46	20.30	20.54	20.57	20.86	20.88	20.58	20.15	11.98
Average	15.104	15.018	15.160	15.198	15.396	15.368	15.162	14.423	8.19
% Increment Over Position 3:	0.00	-0.569	+0.371	+0.622	+1.93	+1.75	+0.384	-0.838	
Series SNG 3" Stack Height	10.29	10.39	10.38	10.42	10.52	10.49	10.41	10.31	4.60
	12.57	12.62	12.63	12.68	12.81	12.79	12.69	12.57	6.34
	14.83	14.80	14.81	14.95	15.11	15.07	14.95	14.76	7.88
	16.87	16.82	16.91	17.00	17.21	17.17	16.99	16.81	9.58
	19.84	19.75	19.85	19.94	20.24	20.17	19.94	19.73	11.96
Average	14.880	14.876	14.916	14.998	15.178	15.138	14.996	14.836	8.07
% Increment Over Position 3:	0.00	-0.027	+0.242	+0.793	+2.00	+1.73	+0.780	-0.296	

EXHAUST NOZZLE AND STACK TESTS¹ - ENGINE 4401
 PROBABLE LOCATION OF DRAFT ISOBARS ON FRONT TUBE SHEET
 INDICATING DRAFT INCREMENTS SHOWN AS A PERCENTAGE OF DRAFT AT
 POSITION No. 3, 44½" AHEAD OF FRONT TUBE SHEET.

• POSITION OF DRAFT TUBES
 NOS. 4-10, 2" AHEAD OF
 FRONT TUBE SHEET.

½" SQUARE BASKET BRIDGE CROSS SPLIT
 BASKET NETTING SPARK ARRESTOR
 8" DIA. NOZZLE 20" DIA. STACK



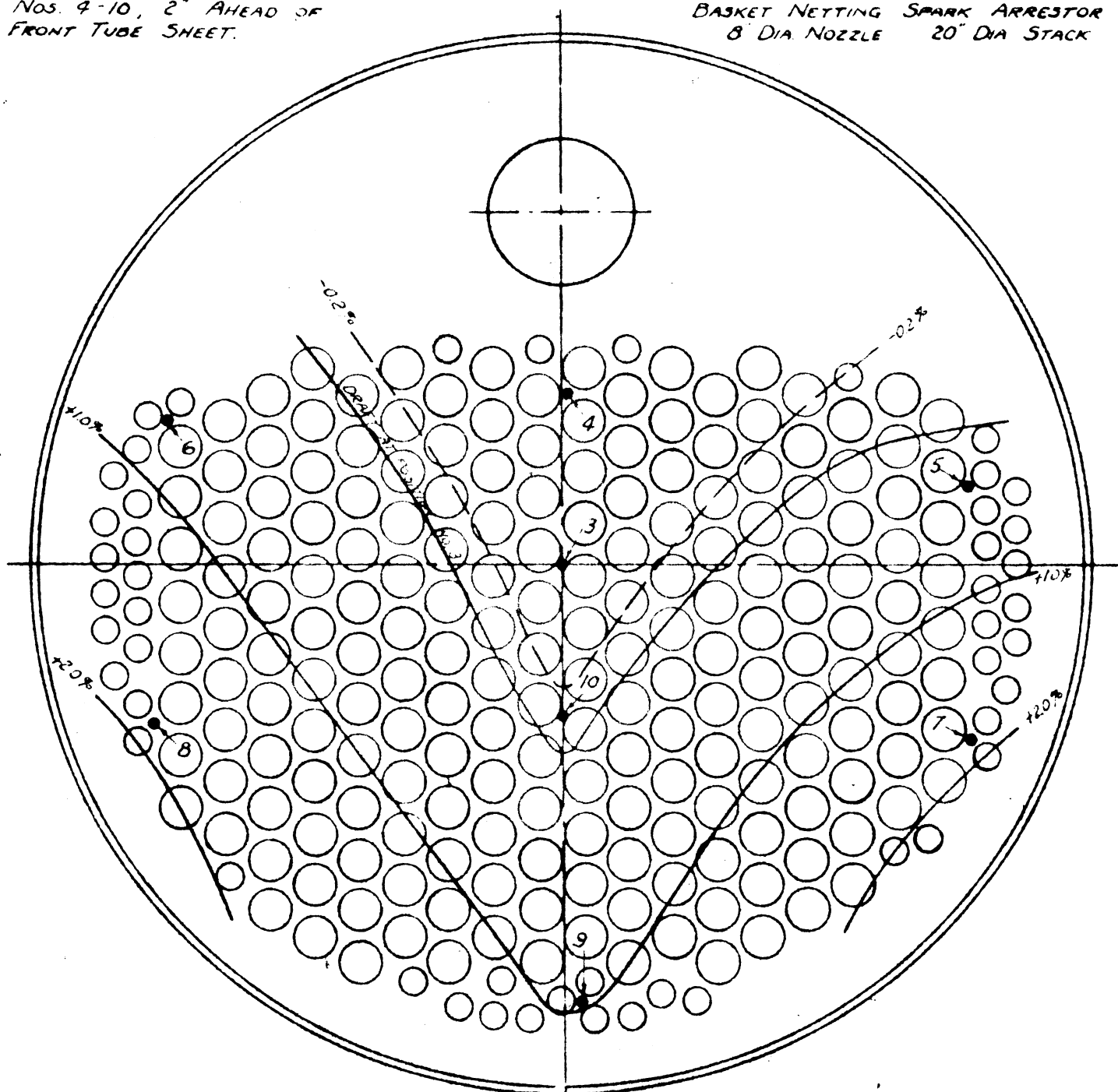
TEST SERIES "SND"
 13¼" STACK HEIGHT ABOVE NOZZLE

5T-184

EXHAUST NOZZLE AND STACK TESTS - ENGINE 4401
PROBABLE LOCATION OF DRAFT ISOBARS ON FRONT TUBE SHEET
INDICATING DRAFT INCREMENTS, SHOWN AS A PERCENTAGE OF DRAFT AT
POSITION NO.3, 44 1/2" AHEAD OF FRONT TUBE SHEET.

● POSITION OF DRAFT TUBES
NOS. 4-10, 2" AHEAD OF
FRONT TUBE SHEET.

1/2" SQUARE BASKET BRIDGE CROSS SPLIT
BASKET NETTING SPARK ARRESTOR
8" DIA NOZZLE 20" DIA STACK



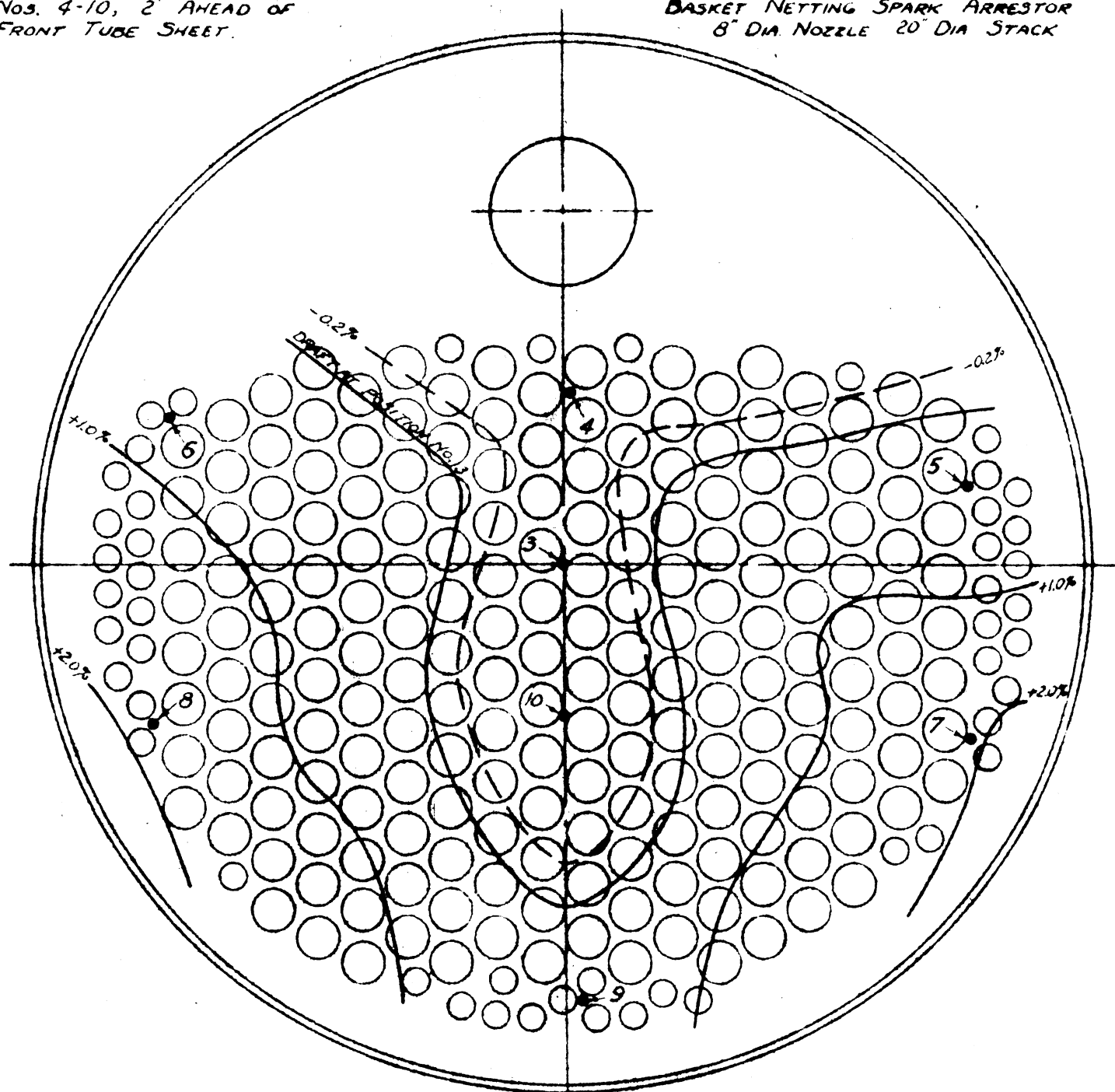
TEST SERIES "SNE"
7" STACK HEIGHT ABOVE NOZZLE

ST-185

EXHAUST NOZZLE AND STACK TESTS - ENGINE 4401 PROBABLE LOCATION OF DRAFT ISOBARS ON FRONT TUBE SHEET INDICATING DRAFT INCREMENTS SHOWN AS A PERCENTAGE OF DRAFT AT POSITION No. 3, 44½" AHEAD OF FRONT TUBE SHEET.

• POSITION OF DRAFT TUBES
 Nos. 4-10, 2" AHEAD OF
 FRONT TUBE SHEET.

½" SQUARE BASKET BRIDGE CROSS SPLIT
 BASKET NETTING SPARK ARRESTOR
 8" DIA NOZZLE 20" DIA STACK

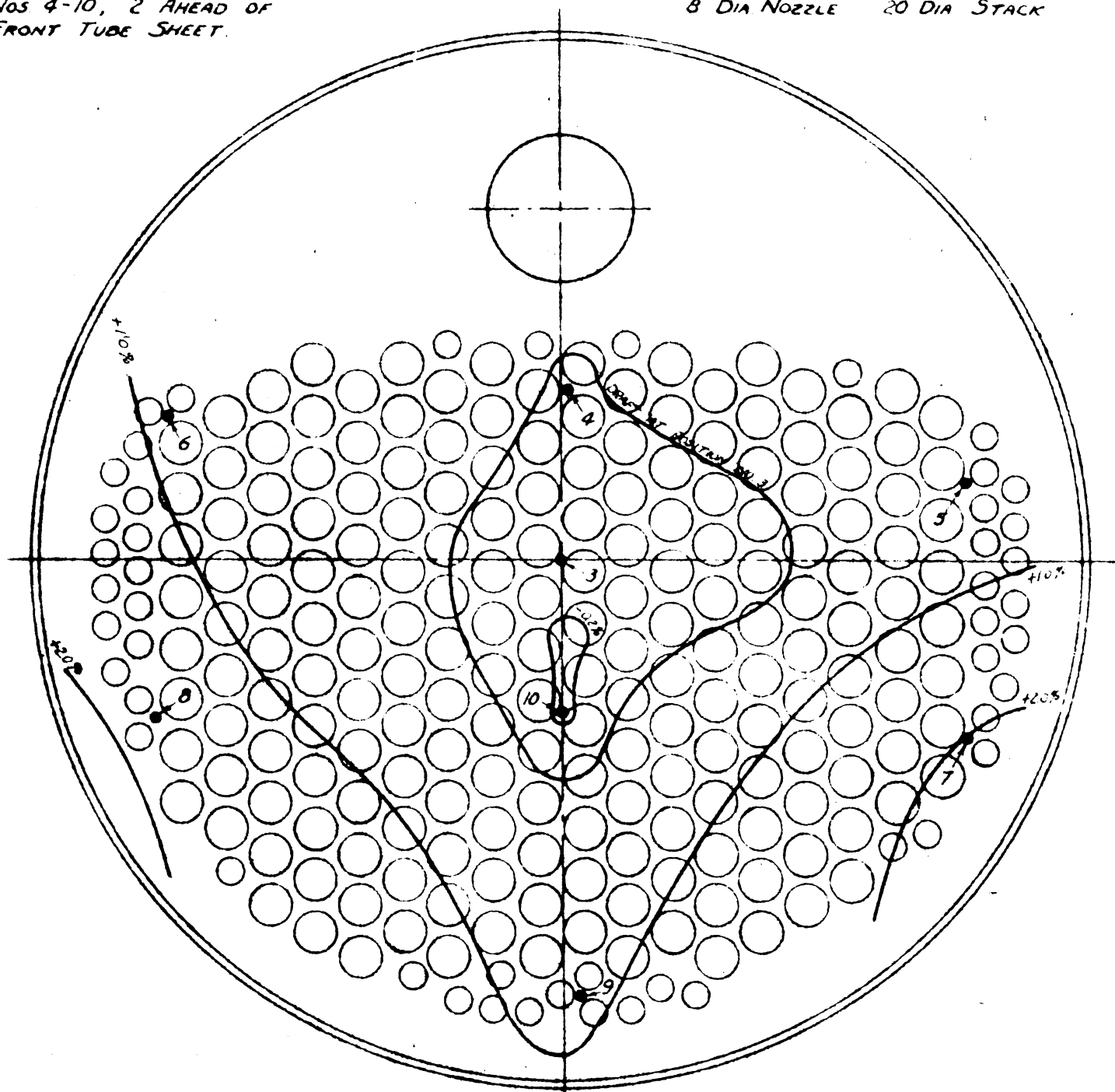


TEST SERIES 'SNF'
 10' STACK HEIGHT ABOVE NOZZLE

EXHAUST NOZZLE AND STACK TESTS - ENGINE 4401
PROBABLE LOCATION OF DRAFT ISOBARS ON FRONT TUBE SHEET
 INDICATING DRAFT INCREMENTS SHOWN AS A PERCENTAGE OF DRAFT AT
 POSITION NO. 3, 44½" AHEAD OF FRONT TUBE SHEET.

● POSITION OF DRAFT TUBES
 NOS 4-10, 2" AHEAD OF
 FRONT TUBE SHEET.

½ SQUARE BASKET BRIDGE CROSS SPLIT
 8 DIA NOZZLE 20 DIA STACK



TEST SERIES "SNG"

3" STACK HEIGHT ABOVE NOZZLE - WITHOUT SPARK ARRESTOR

DATA USED IN PLOTTING "PROBABLE LOCATION OF FLUE GAS ISOTHERMS ON FRONT TUBE SHEET"

TEMPERATURE POSITION NO.	SMOKEROX TEMPERATURE - OF.								Exhaust Nozzle Pressure PSIG
	1	2	3	4	5	6	7	8	
Series SND	547.4	546.8	536.2	567.6	537.1	576.7	556.0	576.4	6.30
13½" Stack Height	560.2	557.7	551.2	580.7	552.0	592.1	574.3	603.9	7.79
	578.8	570.8	563.3	593.3	575.0	619.0	600.4	617.0	9.80
	586.4	578.3	572.2	603.2	583.2	627.1	605.1	624.3	12.06
% Increment Over Position 1:	0.00	-0.8	-2.2	+2.8	-1.1	+6.2	+2.8	+6.5	
Series SNE	526.2	519.4	518.8	542.1	517.6	557.5	534.7	557.8	4.63
7" Stack Height	543.7	538.1	532.7	564.5	532.9	569.9	552.1	575.3	6.23
	564.5	554.6	551.5	576.5	552.9	599.2	571.6	595.6	7.88
	569.9	554.4	554.6	586.6	558.7	600.1	581.5	605.9	9.73
	591.6	578.1	568.7	601.5	579.1	618.6	605.3	628.9	12.04
% Increment Over Position 1:	0.00	-1.8	-2.5	+2.7	-2.0	+5.4	+1.8	+6.0	
Series SNF	518.4	511.1	513.9	539.4	510.4	545.4	527.5	551.7	4.76
10" Stack Height	538.8	528.8	532.6	561.8	530.5	569.2	549.1	571.4	6.37
	557.4	548.7	546.4	577.6	547.8	586.4	566.1	582.4	7.95
	569.3	558.4	554.4	586.0	560.4	600.0	578.5	595.4	9.90
	579.5	565.8	564.7	600.0	568.4	612.5	589.4	618.2	11.98
% Increment Over Position 1:	0.00	-1.82	-1.83	+3.7	-1.66	+5.4	+1.7	+5.6	
Series SNG	519.7	518.7	515.7	541.5	510.7	541.7	527.7	552.1	4.60
3" Stack Height	537.1	535.9	529.0	558.7	528.7	564.5	545.9	566.5	6.34
	558.4	552.0	546.3	576.8	552.2	588.8	570.5	584.9	7.88
	579.6	569.3	560.7	591.5	573.9	612.4	593.5	603.6	9.58
	587.2	577.1	566.6	602.4	578.4	617.8	599.3	605.2	11.96
% Increment Over Position 1:	0.00	-1.0	-2.2	+3.2	-1.4	+5.1	+2.0	+4.7	

EXHAUST NOZZLE AND STACK TESTS - ENGINE 4401

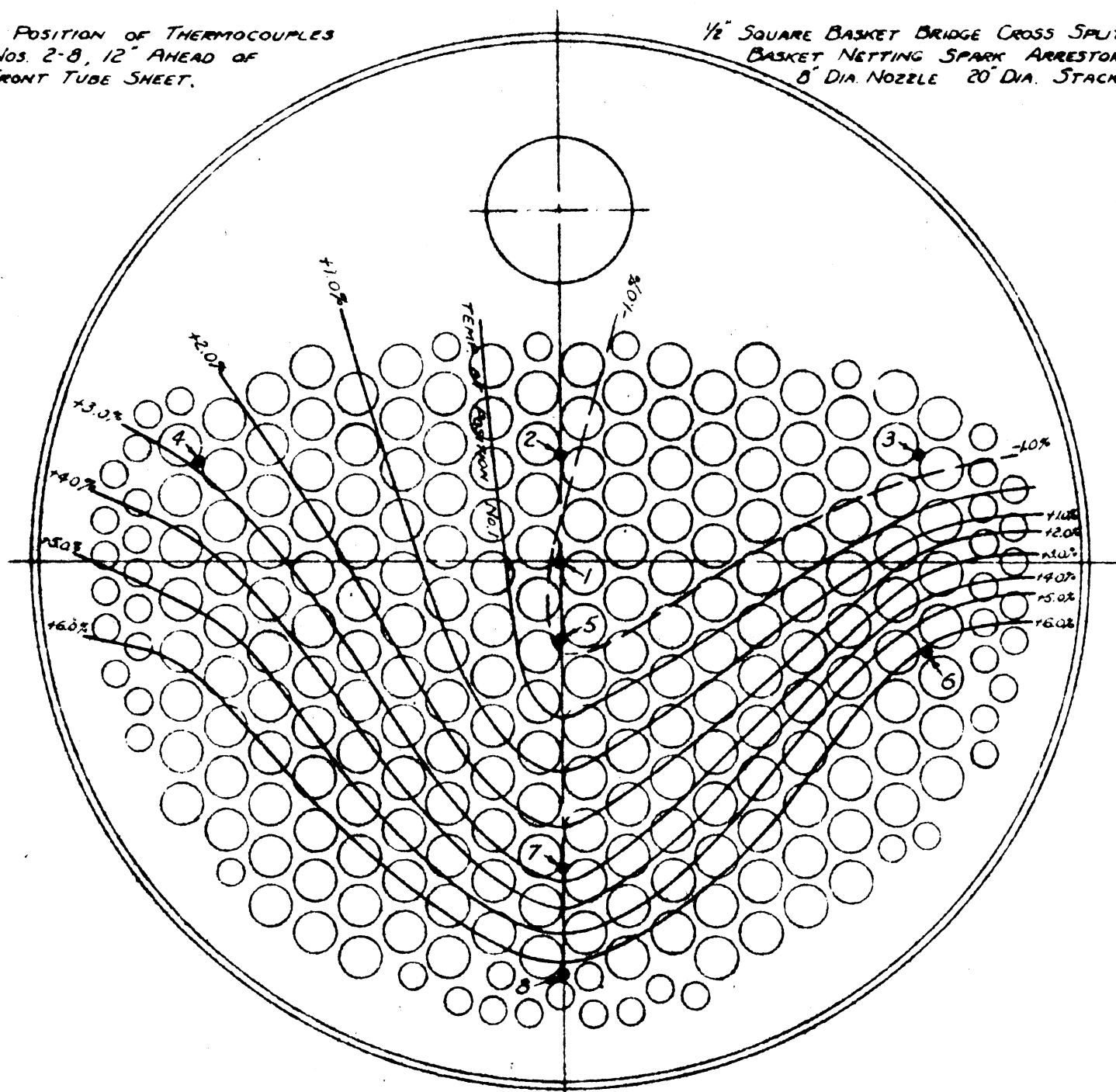
PROBABLE LOCATION OF FLUE GAS

ISOTHERMS ON FRONT TUBE SHEET

INDICATING TEMPERATURE INCREMENTS SHOWN AS A PERCENTAGE OF TEMPERATURE AT POSITION NO. 1, 48 1/2" AHEAD OF FRONT TUBE SHEET.

● POSITION OF THERMOCOUPLES
NOS. 2-8, 12" AHEAD OF
FRONT TUBE SHEET.

1/2" SQUARE BASKET BRIDGE CROSS SPLIT
BASKET NETTING SPARK ARRESTOR
8" DIA. NOZZLE 20" DIA. STACK



TEST SERIES "SND"

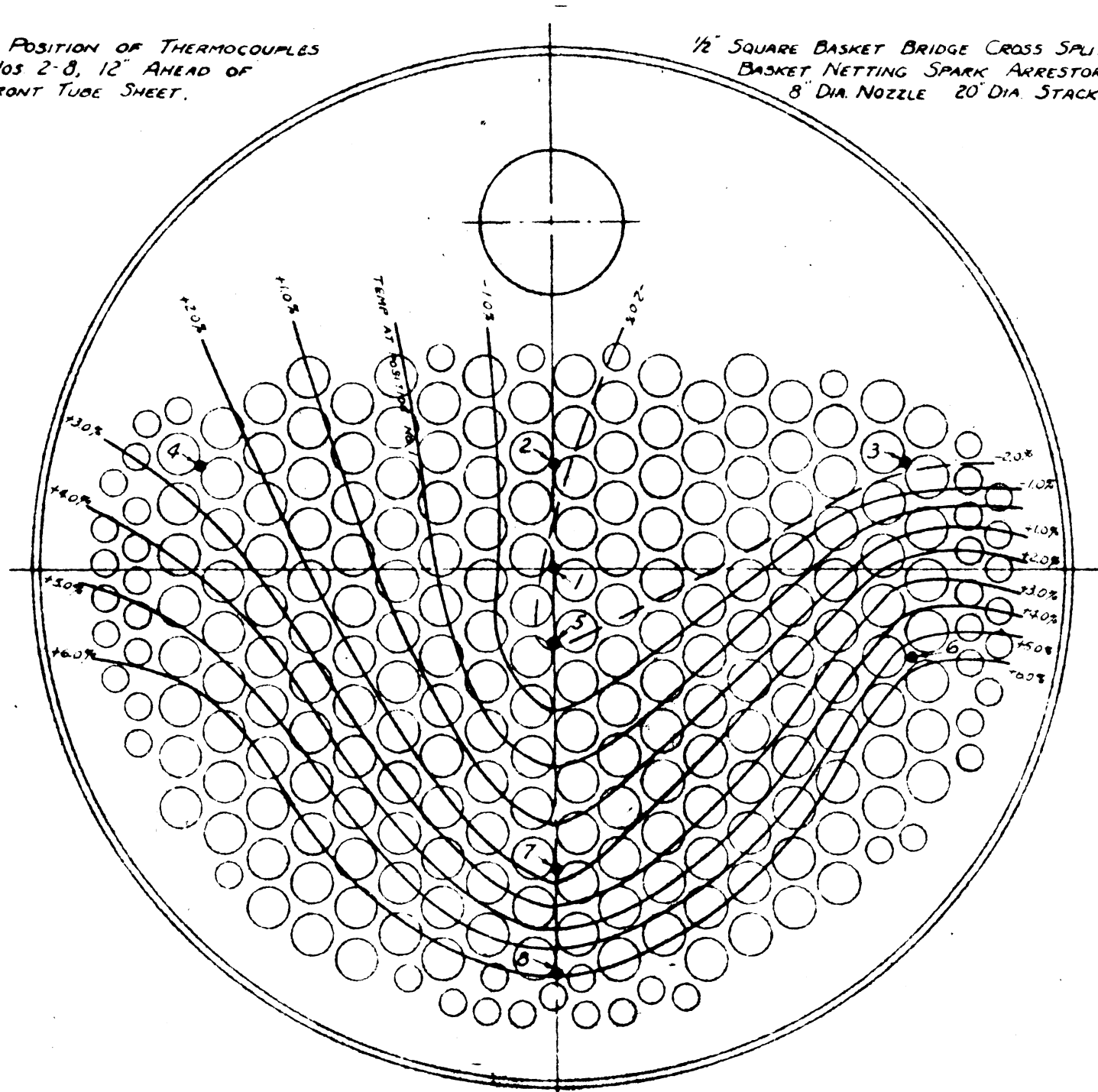
13 1/4" STACK HEIGHT ABOVE NOZZLE

EXHAUST NOZZLE AND STACK TESTS - ENGINE - 4401
PROBABLE LOCATION OF FLUE GAS
ISOTHERMS ON FRONT TUBE SHEET

INDICATING TEMPERATURE INCREMENTS SHOWN AS A PERCENTAGE OF
 TEMPERATURE AT POSITION No.1, 48 1/2" AHEAD OF FRONT TUBE SHEET.

● POSITION OF THERMOCOUPLES
 Nos 2-8, 12" AHEAD OF
 FRONT TUBE SHEET.

1/2" SQUARE BASKET BRIDGE CROSS SPLIT
 BASKET NETTING SPARK ARRESTOR
 8" DIA. NOZZLE 20" DIA. STACK



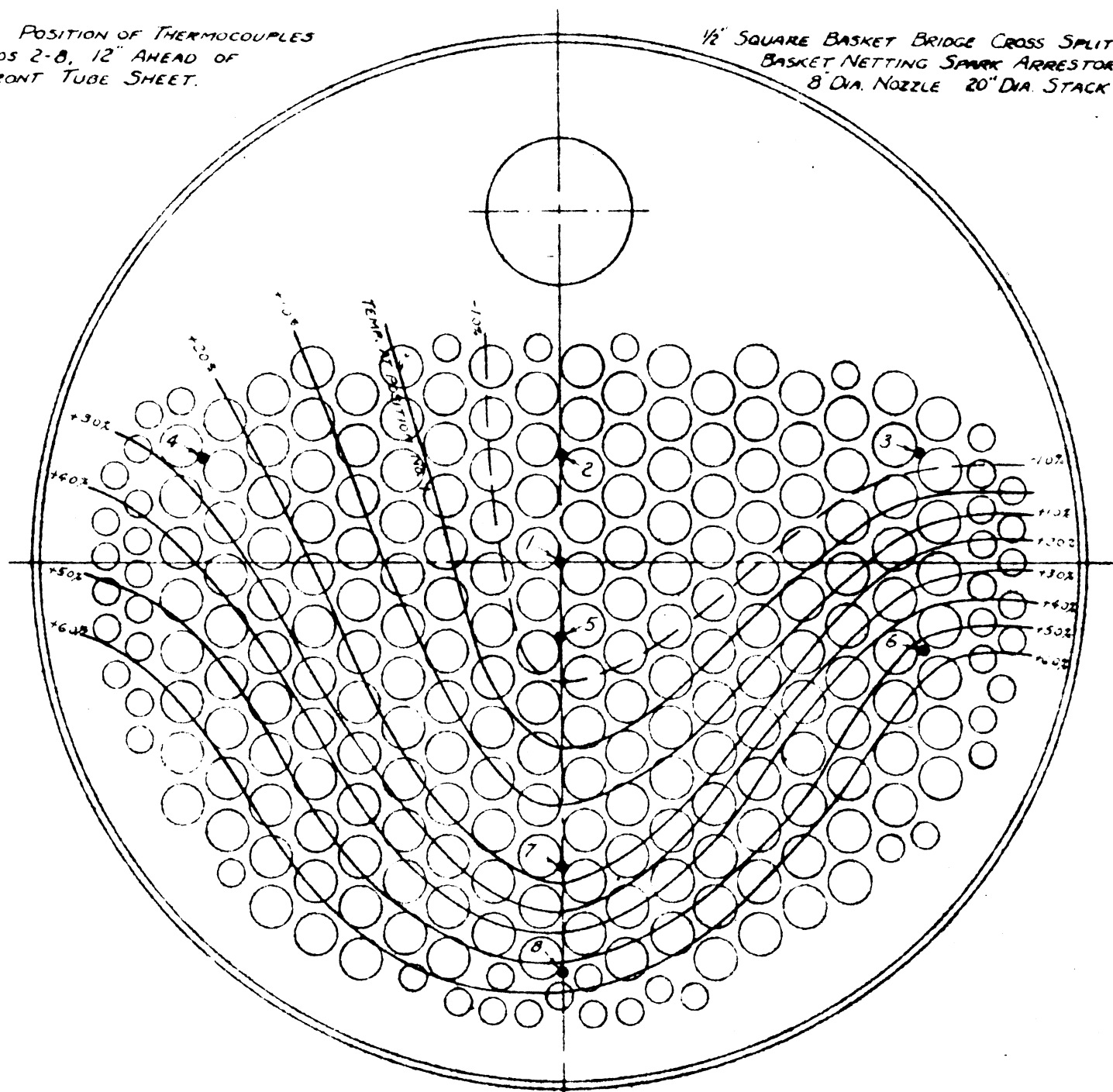
TEST SERIES "SNE"
7" STACK HEIGHT ABOVE NOZZLE

EXHAUST NOZZLE AND STACK TESTS - ENGINE 4401
PROBABLE LOCATION OF FLUE GAS
ISOTHERMS ON FRONT TUBE SHEET

INDICATING TEMPERATURE INCREMENTS SHOWN AS A PERCENTAGE OF TEMPERATURE AT POSITION NO. 1, 48 1/2" AHEAD OF FRONT TUBE SHEET.

● POSITION OF THERMOCOUPLES
Nos 2-8, 12" AHEAD OF
FRONT TUBE SHEET.

1/2" SQUARE BASKET BRIDGE CROSS SPLIT
BASKET NETTING SPARK ARRESTOR
8" DIA. NOZZLE 20" DIA. STACK



TEST SERIES "SNF"
10" STACK HEIGHT ABOVE NOZZLE

STANDING TEST PLANT, SACRAMENTO

FIG. 2-64

APRIL 1, 1948

57-191

EXHAUST NOZZLE AND STACK TESTS - ENGINE 4401

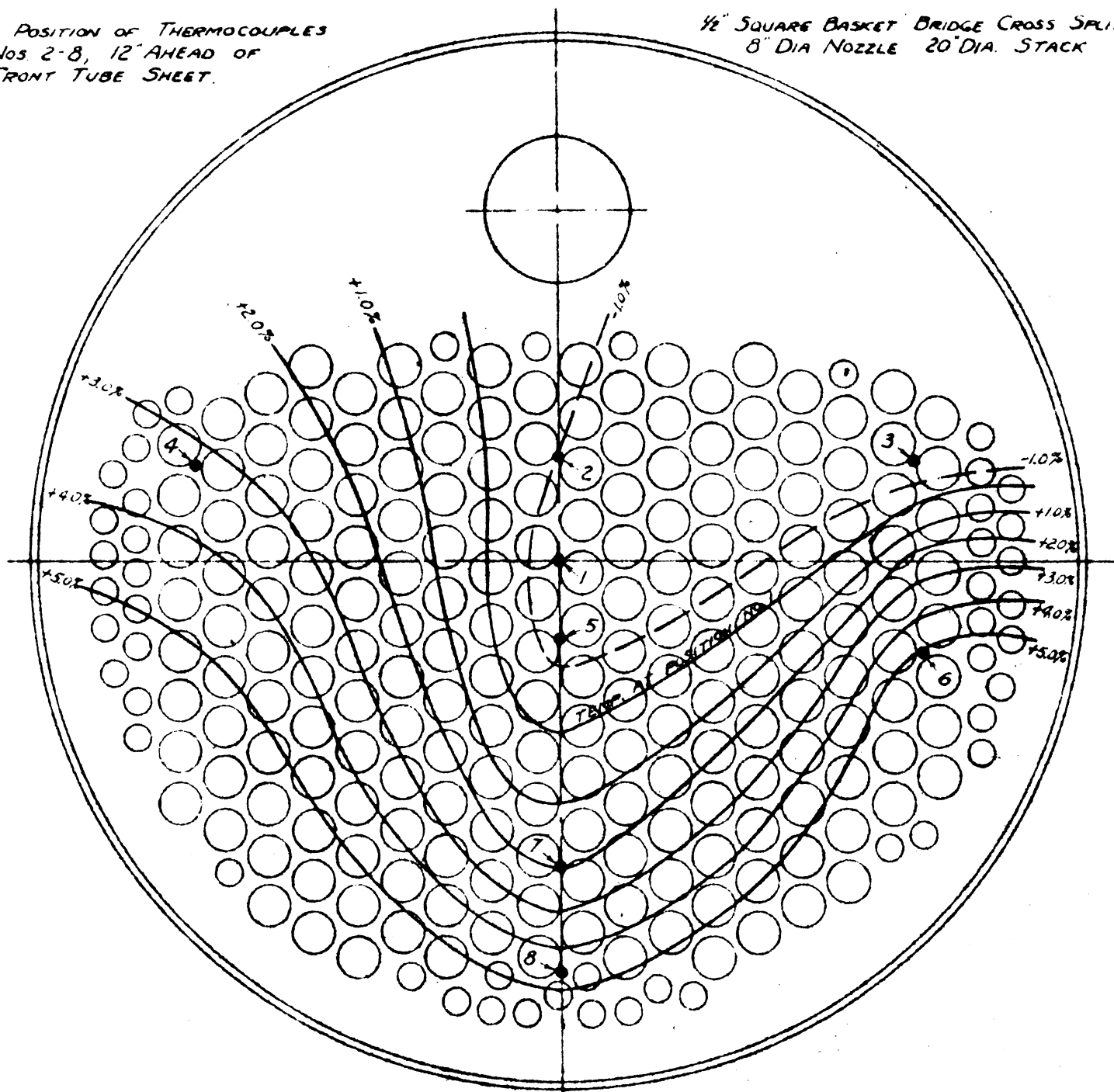
PROBABLE LOCATION OF FLUE GAS

ISOTHERMS ON FRONT TUBE SHEET

INDICATING TEMPERATURE INCREMENTS SHOWN AS A PERCENTAGE OF TEMPERATURE AT POSITION NO. 1, 98 1/2" AHEAD OF FRONT TUBE SHEET.

● POSITION OF THERMOCOUPLES
Nos 2-8, 12" AHEAD OF
FRONT TUBE SHEET.

1/2" SQUARE BASKET BRIDGE CROSS SPLIT
8" DIA NOZZLE 20" DIA. STACK

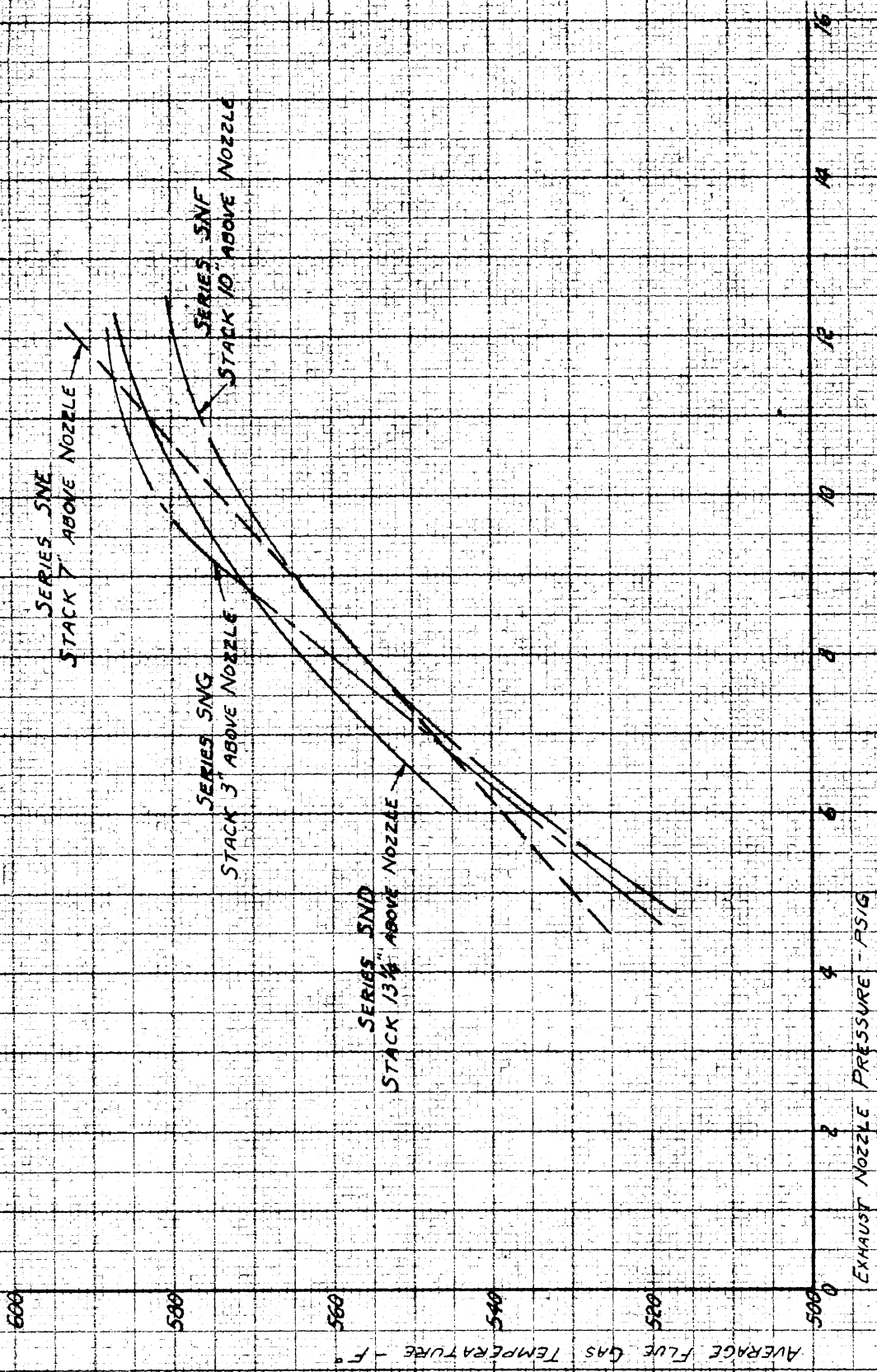


TEST SERIES "SNG"

3" STACK HEIGHT ABOVE NOZZLE - WITHOUT SPARK ARRESTOR

STANDING TEST PLANT, SACRAMENTO FIG. 2-65

APRIL 1, 1948



FLUE GAS TEMPERATURES VS EXHAUST NOZZLE PRESSURE 8" NOZZLE - 1/2" BASKET BRIDGE SPLIT

ENGINE 8401

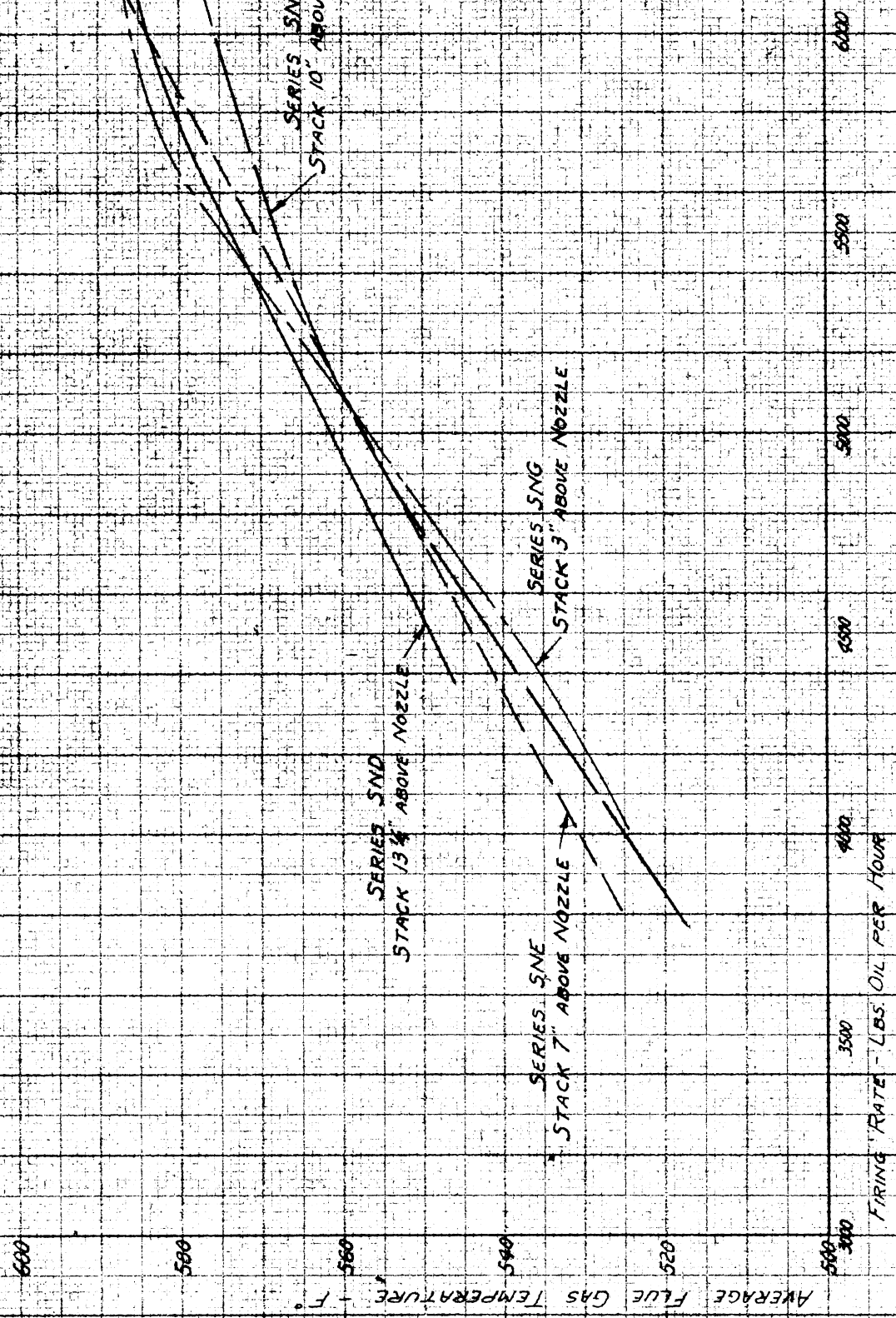
STANDING TEST

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

Fig. 2-66

ST-193



FLUE GAS TEMPERATURES VS FIRING RATE

8" NOZZLE - 1/8" BASKET BRIDGE SPLIT

ENGINE #401

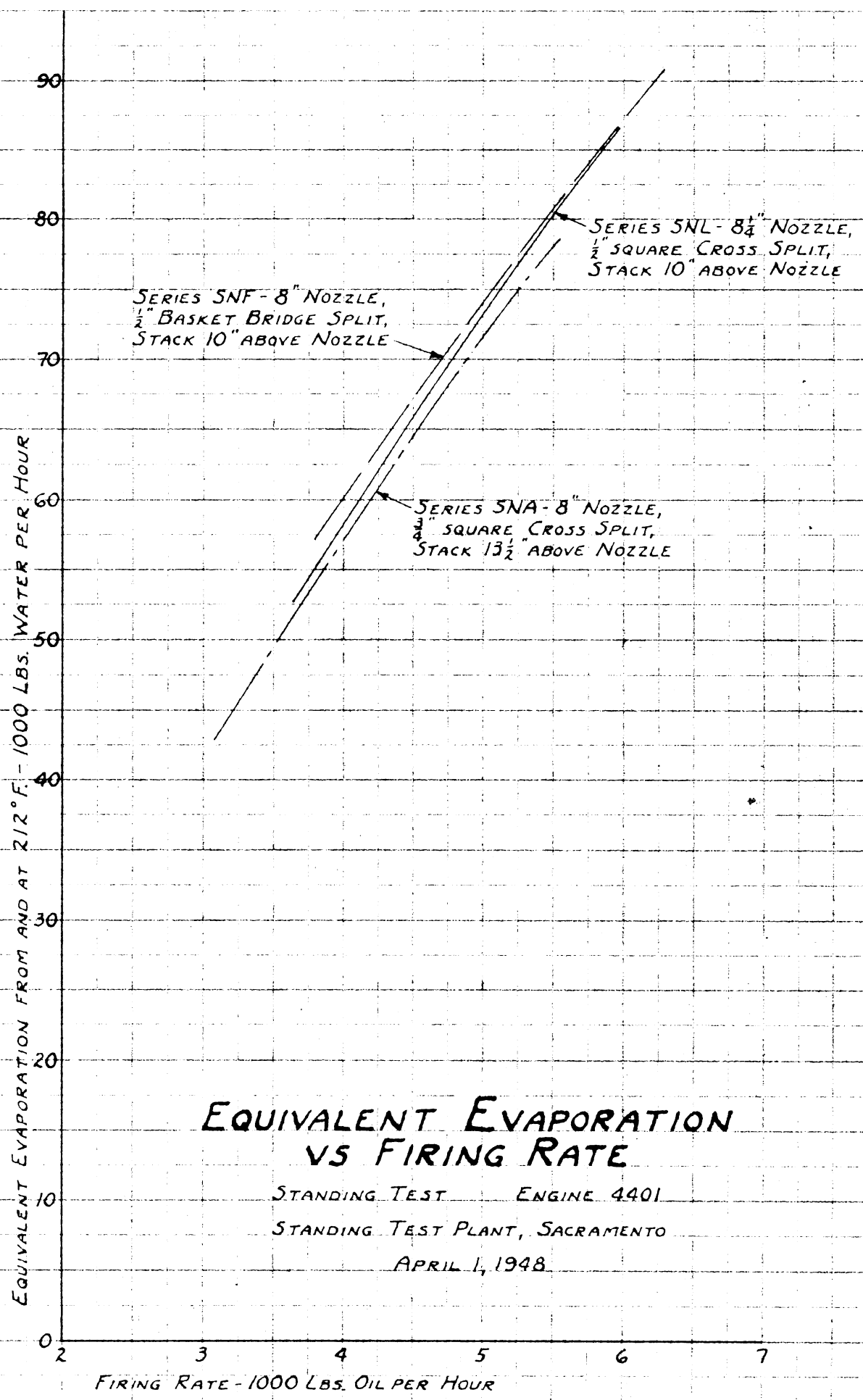
STANDING TEST

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 2-67

ST-195



EQUIVALENT EVAPORATION VS FIRING RATE

STANDING TEST ENGINE 4401
STANDING TEST PLANT, SACRAMENTO
APRIL 1, 1948

Fig. 2-68