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NEPA 1635

MONTHLY PROGRESS REPORT

Covering the Period October 15, 1950 to
November 15, 1950

DATE November 16, 1950

Work performed by

CALIFORNIA RESEARCH CORPORATION
RICHMOND, CALIFORNIA

R. O. Bolt
J. G. Carroll

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Y-237-1

MONTHLY PROGRESS REPORT COVERING THE
OCTOBER 15, 1950, TO NOVEMBER 15, 1950

(1½) —— ~~By R. O. Bolt and J. G. Carroll~~ -By R. O. Bolt and J. G. Carroll - UNCLASSIFIED

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(1½)

CALIFORNIA RESEARCH CORPORATION
RICHMOND, CALIFORNIA

CRC-NEPA REPORT NO. 39
NEPA CONTRACT NO. SC-2011
PROGRESS REPORT - OCTOBER 15-NOVEMBER 15, 1950

FILE 230.31
NOVEMBER 16, 1950

Abstract

(1) Oil samples in sealed ~~ampoules~~ ampules treated with gamma radiations from Hanford slugs have exhibited appreciable viscosity increases. One series of tests conducted at about 140°C. with an exposure of ~~about~~ approximately 6 x 10^7 R shows little viscosity change. Another series at 38°C. and 4 x 10^8 R exhibits much greater thickening. Aromatic compounds are much more radiation-resistant than other types of materials in these tests.

The gamma dosage in the 140° experiments approximates one-seventh of that obtained for one month in pile experiments at Oak Ridge while the dosage of the 38° experiments is about equal to that received by the Oak Ridge samples in one month. Since the gamma flux from the Hanford slugs is approximately 10% of that present in the X-10 pile, the radiation damage to fluids exposed only to gamma flux assumes greater significance than previously was supposed.

New irradiation experiments on possible shield materials have shown that the lower-boiling ~~homologs~~ homologues of the basic types of oils developed previously respond to inhibitors in much the same ways as the prior fluids. However, the level of deterioration is greater on certain of the more volatile products. This may be explained in terms of structural differences. Materials containing iodine are still the most effective agents in protecting both new and old fluids from radiation damage; only bromine of the other common halogens has a slight beneficial effect. The optimum concentration of iodobenzene in a diester oil is between ~~eight~~ 8 and ~~sixteen~~ 16 per cent for one month of irradiation in Oak Ridge at near maximum flux.

Irradiation experiments at 180°C. and 220°C. are now in progress in Oak Ridge. All arrangements have been completed for static tests on fluid samples in a Hanford pile. The effects of increased temperature and of increased flux are thus being investigated in this new work which is scheduled for completion within the coming month.

Encl.-Tables I through VII
Chart I
Photograph

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Static Irradiations

Batch 11

About half ~~of~~ the samples of this group have now been received at Richmond and evaluated. This work, conducted in cooperation with ~~Mr.~~ K. N. Mathes, involved irradiations at Hanford with gamma rays from slugs discharged from one of the piles. The slugs were placed around slug cans containing the fluid samples in sealed glass ampoules. The experiments were conducted under ~~twenty-five feet~~ 25 ft of water at about 38°C. The active slugs were replaced periodically in order to maintain an average intensity at the samples ~~of~~ the order of 5×10^4 R/hr. This is equivalent to about one-tenth of the gamma flux (10^{11} ~~gammas~~/cm.^{2}/sec.) received by samples in the Oak Ridge pile. The Batch 11 samples were treated in this way for a period of about six months so that a total average exposure of approximately 4×10^8 R was obtained. This approximates the gamma portion of the combined exposure given the Oak Ridge samples in one month. Thus the viscosity changes noted are definitely significant.

T1&2 Table 1 is a summary of the data on this group of samples. Table ~~II~~ 2 supplements Table 1 with the Batch 11 exposure history. It can be noted that the aromatic compounds appear to be the most resistant to viscosity increase on bombardment with the gamma radiations. Such materials are also effective to a lesser extent in protecting less stable products from similar damage. The ester type of oil, typified by both alkyl and aryl diesters, is damaged to a considerable extent under the indicated conditions as is the ether-linked oil [poly(propene oxide)]. The addition of iron and copper wires to the fluids appears to have no effect on the viscosity increase.

These data show that damage due to the action of gamma radiations is not a minor effect and, in all probability, contributes a material increment to the viscosity increases observed in samples exposed in the pile. More quantitative comparisons of the effects of gamma rays and pile radiations is to be undertaken in the near future.

Batch 12

T3 Table ~~III~~ 3 is a summary of the data obtained on these samples. These experiments were conducted at Hanford with gamma radiations in the same manner as was the work of Batch 11. However, the Batch-12 samples ~~were treated at a~~ approximately temperature of about 140°C for a total exposure of ~~about~~ 6×10^7 R. The gamma flux is again about one-tenth of the gamma portion of the combined flux obtained in the Oak Ridge pile. The dose is approximately one-seventh of the gamma portion of the one-month Oak Ridge exposure.

The effects noted under the new conditions are much milder than those of Batch 11. However, here again the superiority of the aromatic type of compound is evident. The milder effects can be attributed to the lower dose and/or to the higher temperature. It is interesting to note that even this comparatively mild gamma radiation decomposed the thickener-V.I. improver employed in ampoule 520. Thus the beginning viscosity of the material irradiated is higher than the final viscosity. This same effect has been noted in previous work with pile radiations.

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Batch 18 .

Data on the A or one-week samples of this group have already been summarized in CRC-NEPA Report No. 35. The B or four-week samples have now been evaluated. Table ~~IV~~ 4 is a summary of all ~~of~~ the data on Batch 18 samples.

(T4)→ The primary purpose of this work is to investigate the effect of pile radiations on low-boiling products which may be suitable for shield materials. The action of certain inhibitors on these and similar products is also being investigated.

1/2

Light Petroleum Distillate.

A typical material of this sort exhibits rather high viscosity increases in the pile. However, the material responds well to inhibitors such as dialkyl selenide. Materials containing iodine are even more effective in this regard. The best A_{59} value (0.36) obtained for a compounded sample of this material is inferior to that obtained previously for several non-petroleum products.

1/2

Alkylbenzene (MW ≅ 250).

This fluid has been interesting as a possible shield material in past work. The product responds ~~to a~~ slightly ~~extent~~ to the action of inhibitors both of the oxidation and radical-reaction types. The greatest improvement is obtained with materials containing iodine. The best A_{59} value (0.17) for a compounded sample of this fluid is within the range considered acceptable for possible use under mild flux conditions.

1/2

Dimethoxytetraglycol.

This compound, similar to the poly(propene oxide) type of material, was used in the present work because of its physical characteristics approximating those desired in shield materials. It was found that the new product is damaged more extensively by pile radiations than would be expected from data on poly(propene oxide). Structural variations (no chain branching in the glycol derivative) may explain these differences. The new product appears to respond reasonably well to the action of the oxidation type of inhibitor such as dialkyl selenide. Iodine compounds are not ~~as~~ so effective with this compound as with other synthetic fluids. Poly(propene oxide) also does not respond well to this type of inhibitor.

1/2

Diesters.

The diethyl adipate used in the present work as a possible shield material has proved inferior from a viscosity-increase standpoint to the di(2-ethylhexyl) sebacate employed in previous work. This results from the fact that the adipate appears to respond to a much lesser extent to inhibitors than does the sebacate. The best inhibitors for both ~~of~~ these materials appear to be compounds containing iodine. The inferiority of the new ester may be explained on the basis of differences in molecular structure.

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¶ Inhibitors

Several materials containing common halogens were investigated in di(2-ethylhexyl) sebacate in the hope of discovering new compounds as effective inhibitors. This base oil was chosen because of its ability to respond well to the action of the radical-reaction type of inhibitor from the standpoint of protection against pile radiations. It was found that iodine compounds are in a class by themselves among the halogens in this regard. Compounds containing bromine were observed to have a slight beneficial effect, whereas materials containing chlorine and those containing fluorine are ineffectual.

It has been stated previously that iodonaphthalene was slightly superior to iodobenzene in certain base oils. The data on Batch-18B samples appear to refute this contention. In fact, there seems to be little difference between these two materials and methylene iodide or iodobiphenyl when these products are used in the sebacate in 5% concentrations.

1/2

¶ Special Products

A typical lubricating oil, heavily compounded with both oxidation and radical-reaction inhibitors and diluted with 1-methylnaphthalene, was found to have an A_{59} value of 0.28. This fluid is thus relatively radiation-resistant and might be used under mild conditions as a shield material.

1/2

¶ ~~The~~ Effect of Iodobenzene

T5 Table ~~V~~ 5 summarizes data obtained with various concentrations of this inhibitor in the sebacate oil. These data demonstrate that the optimum concentration of this inhibitor is somewhere between 8 and 16% for four-week exposures under mild temperature conditions. One-week exposures indicate that the optimum concentration is between 4 and 8%. It thus appears that the iodine is dissipated during the course of irradiation. This has been reported previously. If longer irradiation periods are to be employed, it would seem that larger concentrations of the iodine compound would be optimum.

1

Batches 20 and 21

1/2

It will be recalled that the data from the Batch 19 samples, which were irradiated at X-10 at 140°C, show that at this increased temperature the viscosity increases of the fluids tested are slightly less than those observed at lower temperatures. Therefore, it was decided to conduct experiments at 180°C and 220°C in an effort to investigate further the effect of elevated temperatures. Batches 20 and 21 are being irradiated at these ~~indicated~~ temperatures. Table ~~VI~~ 6 T6 lists the samples in these two groups. The fluids employed are almost identical with those used in Batch 19.

The two new groups of samples were introduced into Hole 54N of the X-10 pile on October 16 and are to remain in the pile until November 20. At ~~this time~~ that they will have received radiation dosages approximately equivalent to that received by the Batch 19 samples. The equipment employed in this new work resembles

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that used in the past except that the ovens were equipped with typical flat iron heaters rather than bare resistance wire heaters. The fire hazard caused by the hot wires at elevated temperatures was thus reduced. It is planned to remove the samples from the ovens during the week of November 27 so that these materials may be returned at once to Richmond for evaluation before the first of the year.

①

Work at Hanford

(1/2)

The samples (Batch 22) to be irradiated at Hanford in the investigation of the effect of magnitude of flux were shipped ~~to Mr. Lather~~ on November 8. These materials are contained in vessels which were specially designed in cooperation with Hanford personnel. X

(1/2)

Containers ①

Fig. 1 → ~~Chart I is~~ a machine drawing of the containers (is shown in Fig. 1.) They were designed to withstand pressures resulting from the complete decomposition of the samples contained therein. Extensive test work has shown that these vessels will withstand 9,000 to 10,000 ~~pounds~~ psi before leakage occurs through the gasket seal. Deformation of the cell proper takes place at pressures in excess of 10,000 ~~pounds.~~ lb. Since leakage through the gasket occurs at lower pressures than this, it is unlikely that deforming pressures can be attained in actual practice. The new pressure vessels, Fig. 2, have been constructed entirely of full hard 2S aluminum with the exception of the lead gasket material. This was done in order to permit easy handling of the irradiated cells after a short-activity decay period. 2S

(1/2)

Procedure ①

The irradiation period to be employed (about 14 ~~hours~~ hr) is the shortest that ~~which can~~ be obtained at Hanford. The samples will be placed in the pile in such positions so that exposures equivalent to one- and four-week irradiations at Oak Ridge will be obtained. In this way damage at the two different flux levels can be readily compared. The Oak Ridge experiments will not be strictly comparable to the Hanford experiments because of temperature differences and, more important, because the Oak Ridge irradiations were conducted in vented ampoules, whereas those at Hanford will be conducted in sealed containers. Thus there is a deficiency of oxygen in the Hanford samples. This deficiency is further enhanced by the fact that the Hanford samples have been sealed under helium. This gas was used because it does not interfere with the mass-spectrometer measurements to be conducted on gas samples from the containers.

The gas samples are to be taken about two weeks after irradiation. At the same time the pressure in each vessel will be measured and the oil sample removed from the aluminum container for viscosity and other measurements

T 7 → Table ~~VII~~ 7 lists the identities of the samples for the Hanford tests. These materials were chosen because data are available on the fluids at several different temperatures and flux levels. Then too, thought was given to obtaining the new data on the same three basic types of lubricants employed extensively in past work.

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Oxidation Tests

1

No new irradiation work is to be undertaken on this phase of the research. Only reference tests needed for the evaluation of previous pile-oxidation experiments have been started. These are to be completed within the coming month and will permit the summary of all of the oxidation-test results at an early date.

1 1/2

Bearing-Lubrication Tests

1

No new irradiation work is planned for this phase of the problem. The bearings from the low-speed and high-speed tests conducted in the X-10 pile are being examined more thoroughly. The examination will be completed in the near future so that these data may be included in the final report.

R. O. BOLT

J. G. CARROLL

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TABLE ~~I~~ II-1

SUMMARY OF DATA ON BATCH 11 SAMPLES TREATED
GAMMA RADIATIONS AT ABOUT 38°C.

1/2

double rule →

single rule →

Sample Identity	Notebook Ref.	Amp. No.	Heat Cell No.	Total Exposure* R x 10^{-6}	Viscosity, SSU Original 100°F.	Original 210°F.	Irradiated 100°F.	Irradiated 210°F.	Viscosity Index Orig.	Irrad.
Solvent Refined Western Paraffinic Lube Oil (SAE 30)	205-25-1	489	17	412	504	62.6	720	74.3	92	95
Solvent Refined Western Paraffinic Lube Oil (SAE 30) + 20% 1-Methylnaphthalene	205-25-2	490	16	344	140	43.1	191	46.6	113	118
Alkylbenzene (MW ≅ 350) + 2% Dialkyl Selenide	205-29-1	500	16	344	356	47.6	372	48.5	-11	0
Octadecylbenzene + 5% Dialkyl Selenide	205-27-2	495	15	338	62.1	35.8	66.6	36.5	124	127
Octadecylbenzene + 5% Dialkyl Selenide + Iron & Copper Wires	205-27-3	496	15	338	62.1	35.8	66.4	36.4	124	120
Octadecylbenzene + 5% Dialkyl Selenide + 2.5% Mercaptobenzothiazole + Iron & Copper Wires	205-28-1	497	16	344	62.2	35.5	67.1	36.2	104	125
Di(2-ethylhexyl) Sebacate	205-29-1	501	17	412	69.0	37.4	127	44.6	154	150
Di(2-ethylhexyl) Sebacate + 2% Dialkyl Selenide	205-29-3	502	16	344	68.7	37.5	95.3	40.8	160	160
Didecyl Terephthalate + 2% Dialkyl Selenide	205-30-3	505	16	344	241	48.4	333	53.8	91	95
Poly(propene oxide)	205-31-1	506	17	412	265	57.8	639	89.6	135	130
Poly(propene oxide) + 2% Conedendrol	205-33-3	514	15	338	283	59.5	588	85.3	135	130
Poly(propene oxide)-B	205-32-2	510	15	338	95.6	41.1	140	45.3	165	145
Poly(propene oxide)-B + Iron and Copper Wires	205-32-3	511	15	338	95.6	41.1	139	44.9	165	140

¶ *See Table II for exposure data

single rule ↗

line up on decimal points

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TABLE ~~II~~ 2/-1

EXPOSURE DATA FOR BATCH 11 SAMPLES TREATED WITH GAMMA RADIATIONS AT ABOUT 38°C

double rule

no.

11/2

	Heat Cell Number		
	15	16	17
Date Samples Installed in Slug Buckets	2/17/50	2/17/50	2/17/50
Intensity in Slug Bucket 2/17/50, R/Hr, X10^{-3}	127.0	120.0	100.0
Samples and Old Slugs Removed	3/23/50	3/23/50	3/23/50
Intensity in Slug Bucket 3/23/50, R/Hr, X10^{-3}	36.5	32.0	26.5
Exposure Time, Days	34	34	34
Average Exposure, R/Hr, X10 -6	66.7	62.0	51.6
Date Samples Installed in New Slug Buckets	3/24/50	3/24/50	3/24/50
Intensity in New Slug Bucket 3/24/50, R/Hr, X10^{-3}	127.0	127.0	127.0
Samples and Old Slugs Removed	4/21/50	4/21/50	4/21/50
Intensity in Slug Buckets 4/21/50, R/Hr, X10^{-3}	47.0	49.0	47.0
Exposure Time, Days	28	28	28
Average Exposure, R/Hr, X10 -6	58.5	59.1	58.5
Date Samples Installed in New Slug Buckets	4/24/50	4/24/50	4/24/50
Intensity, 4/24/50, R/Hr, X10^{-3}	108.0	108.0	110.5
Samples and Old Slugs Removed	5/16/50	5/25/50	5/16/50
Intensity, Indicated Date, R/Hr, X10 -3	(Est.) 50,	43.0	(Est.) 55,
Exposure Time, Days	22	29	22
Average Exposure, R/Hr, X10 -6	41.8	52.5	43.5
Date Samples Installed in New Slug Buckets	5/26/50	5/26/50	5/26/50
Intensity, 5/26/50, R/Hr, X10 -3	127.0	117.5	124.0
Samples and Old Slugs Removed	6/23/50	6/23/50	6/23/50
Intensity, 6/23/50, R/Hr, X10^{-3}	51.0	41.0	44.0
Exposure Time, Days	28	28	28
Average Exposure, R/Hr, X10 -6	59.7	53.3	56.5
Date Samples Installed in New Slug Buckets	6/26/50	6/26/50	6/26/50
Intensity, 6/26/50, R/Hr, X10^{-3}	85.0	80.0	88.0
Samples and Old Slugs Removed	8/4/50	8/4/50	8/4/50
Intensity, 8/4/50, R/Hr, X10^{-3}	32.5	[illegible]	35.0
Exposure Time, Days	43	43	43
Average Exposure, R/Hr, X10 -6	55.0	58.0	63.5
Date Samples Installed in New Slug Buckets	8/11/50	8/11/50	8/11/50
Intensity, 8/11/50, R/Hr, X10^{-3}	99.0	105.0	110.0
Samples and Old Slugs Removed	9/14/50	9/14/50	9/14/50
Intensity, 9/14/50, R/Hr, X10^{-3}	38.5	41.0	43.5
Exposure Time, Days	34	34	34
Average Exposure, R/Hr, X10 -6	56.0	59.5	62.6
Total Average Exposure, R/Hr, X10 -6	337.7	344.4	411.7

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single rule

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TABLE ~~III~~ 3/-1

SUMMARY OF DATA ON BATCH 12 SAMPLES
TREATED WITH GAMMA RADIATIONS AT ABOUT 140°C.

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double rule

single rule

Sample Identity	Note-book Ref.	Amp. No.	Heat Cell No.	*Intensity at Sample: Start 3/14/50 R/Hr. X10^{-3}	*Intensity at Sample: End 4/17/50 R/Hr. X10^{-3}	Total Exposure R X10^{-6}	Viscosity Index: Orig.	Viscosity Index: Irrad.	Viscosity, ~~S.S.U.~~ SSU: Orig~~inal~~ 100°F.	Viscosity, ~~S.S.U.~~ SSU: Orig~~inal~~ 210°F.	Viscosity, ~~S.S.U.~~ SSU: Irradi~~ated~~ 100°F.	Viscosity, ~~S.S.U.~~ SSU: Irradi~~ated~~ 210°F.
Solvent Refined Western Paraffinic ~~Lube~~ Oil (SAE 30)	205-34-1	515	HC-1	102	49.8	61.9	92	92	504	62.6	525	63.9
Di(2-ethylhexyl) Sebacate + 2% Dialkyl Selenide	205-34-2	516	HC-2	103	54.0	64.0	160	160	68.7	37.5	74.1	38.2
Didecyl Terephthalate + 2% Dialkyl Selenide	205-34-3	517	HC-3	99	50.0	60.8	91	94	245	48.6	252	49.1
Poly(Propene Oxide)	205-35-1	518	HC-4	99	45.0	58.7	135	-	265	57.8	Broken via shipment	
Alkylbenzene (MW ≅ 350) + 2% Dialkyl Selenide	205-35-2	519	HC-5	100	56.0	63.6	-11	-7	356	47.6	347	47.5
Alkylbenzene (MW ≅ 250) + 4% Poly(lauryl methacrylate) + 2% Dialkyl Selenide	205-35-3	520	HC-6	108	54.5	66.3	198	68	73.8	38.9	49.9	32.9
Octadecylbenzene + Iron and Copper Wires	205-36-1	521	HC-7	100	48.0	60.4	117	120	62.2	35.6	63.6	35.9
Octadecylbenzene + 5% Dialkyl Selenide + Iron and Copper Wires	205-36-2	522	HC-8	99	60.5	64.9	124	115	62.1	35.8	62.8	35.8

(1/2)

¶ *Slugs out of the pile on March 7, 1950.

single rule

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Irradiated ~~TABLE IV~~ 41-1 (67%)

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SUMMARY OF DATA ON BATCH 18
STATIC SAMPLES IRRADIATED IN THE X-10 PILE FOR ONE AND FOUR WEEKS
AT APPROXIMATELY 1/2 MAXIMUM FLUX AND 65-75°C

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double rule

single rule

Identity	Amp. No.	NOTE Notebook Ref. No.	Dosage Neutrons per cm² x 10⁻¹⁸	Viscosity in Centistokes 100°F Original	100°F Irradiated	210°F Original	210°F Irradiated	Viscosity Index Original	Viscosity Index Irradiated	Color Original	Color Irradiated	Average Irrad. Temp. °C	Asa
Highly Refined Western Naphthenic Distillate	605	460-11-1	0.342	2.87	4.32	1.15	1.44	-	-	Water White	Very Light Amber	65	1.09
	637	460-11-1	1.36	2.87	24.84	1.15	4.115	-	53	Water White	Light Amber	65	0.89
Highly Refined Western ~~Naphthenic~~ naphthenic Distillate + 5% Dialkyl Selenide + 5% Iodobenzene	607	460-11-2	0.347	2.87	3.46	1.14	1.28	-	-	Light Amber	Black	66	0.46
	650	460-11-2	1.38	2.87	8.226	1.14	2.255		135	Light Amber	Black	66	0.36
Highly Refined Western Naphthenic Distillate + 5% Dialkyl Selenide	606	460-11-3	0.342	3.07	4.30	1.2	1.46	-	-	Light Amber	Light Amber	65	0.85
	653	460-11-3	1.36	3.07	23.58	1.2	4.175		78	Light Amber	Dark Orange	65	0.81
Highly Refined Western Naphthenic Distillate + 5% Dialkyl Selenide + 5% Iodonaphthalene	608	460-12-1	0.348	3.03	3.41	1.1	1.27	-	-	Amber	Black	65	0.32
	614	460-12-1	1.24	3.03	7.53	1.1	1.66			Amber	Black	73	0.53
Highly Refined Western Naphthenic Distillate + 10% Butyl Borate + 5% Dialkyl Selenide	609	460-12-2	0.348	3.63	Solid	1.0	Solid	-	-	Water White	-	65	-
	652	460-12-2	1.36	3.63	Solid	1.0	Solid	-	-	Water White	Black	65	-
Alkylbenzene (MW ≅ 250)	610	460-12-3	0.354	6.28	8.27	1.7	2.05	-	20	Water White	Light Amber	66	0.42
	653	460-12-3	1.36	6.28	21.28	1.7	3.410		-20	Water White	Light Amber	66	0.33
Alkylbenzene (MW ≅ 250) + 5% Dialkyl Selenide	611	460-13-1	0.354	6.47	8.03	1.7	2.03	-	27	Light Amber	Light Amber	66	0.29
	654	460-13-1	1.38	6.47	20.7	1.7	3.51		13	Light Amber	Orange	66	0.30
Alkylbenzene (MW ≅ 250) + 5% Dialkyl Selenide + 5% Iodobenzene	612	460-13-2	0.352	5.80	7.08	1.68	1.87	-	-	Light Amber	Black	67	0.38
	655	460-13-2	1.38	5.80	12.96	1.68	2.725		29	Light Amber	Black	66	0.19
Alkylbenzene (MW ≅ 250) + 5% Dialkyl Selenide + 5% Iodonaphthalene	613	460-13-3	0.352	6.28	7.120	1.7	1.88	-	-	Amber	Vy. Dk. Reddish-Brown	66	0.21
	656	460-13-3	1.41	6.28	13.85	1.7	2.8	-	23	Amber	Black	66	0.17
Alkylbenzene (MW ≅ 250) + 5% Dialkyl Selenide + 10% Butyl Borate	614	460-14-1	0.363	5.20	Broken Solid	1.5	Broken Solid	-	-	Amber	-	69	-
	657	460-14-1	1.41	5.20		1.5				Amber	Black	67	-
Dimethoxytetraglycol	615	460-14-2	0.358	2.50	4.0	1.0	1.38	-	-	Water White	Water White	67	1.29
	658	460-14-2	1.43	2.50	19.29	1.0	Bubbles			Water White	Very Light Amber	67	-
Dimethoxytetraglycol + 5% Dialkyl Selenide	616	460-14-3	1.36	2.60	9.48	1.06	2.425	-	81	-	Yellow	67	0.49
Dimethoxytetraglycol + 5% Dialkyl Selenide + 5% Iodobenzene	617	460-15-1	0.359	2.53	3.66	1.04	1.29	-	-	Light Amber	Amber	66	0.92
	660	460-15-1	1.41	2.53	7.974	1.04	2.175		78	Light Amber	Amber	67	0.41
Dimethoxytetraglycol + 3% Dialkyl Selenide + 5% Iodonaphthalene	618	460-15-2	0.359	2.67	3.99	1.0	1.36	-	-	Light Amber	Amber	67	1.00
	661	460-15-2	1.41	2.67	8.567	1.0	2.364		112	Light Amber	Dark Orange	67	0.37
Diethyl Adipate	700	460-16-1	1.43	2.40	20.25	1.0	4.145	-	121	Light Yellow	Yellow	68	0.95
Diethyl Adipate + 5% Dialkyl Selenide	621	460-16-2	1.43	2.50	10.52	1.02	2.765	-	119	Light Yellow	Dark Amber	69	0.80
Diethyl Adipate + 5% Dialkyl Selenide + 5% Iodobenzene	622	460-16-3	0.363	2.40	3.56	1.00	1.28	-	-	Light Amber	Amber	69	1.17
	665	460-16-3	1.43	2.40	8.75	1.00	2.29		75	Light Amber	Dark Orange	68	0.51
Di(2-ethylhexyl) Sebacate + 5% Iodonaphthalene	625	460-17-2	0.365	12.23	19.35	3.23	4.67	153	153	Yellow	Yellow	67	0.58
	668	460-17-2	1.45	12.23	46.5	3.23	7.73	153	134	Yellow	Dark Red	[illegible]	[illegible]
Di(2-ethylhexyl) Sebacate + 5% Iodobenzene	624	460-17-3	0.322	11.33	14.33	3.10	3.63	153	146	Yellow	Black	63	0.38
	667	460-17-3	1.12	11.33	31.10	3.10	5.87	153	148	Yellow	Dark Red-Brown	65	0.27
Di(2-ethylhexyl) Sebacate + 5% Iodobiphenyl	626	460-18-1	0.322	12.27	15.03	3.25	3.63	150	141	Yellow	Black	65	0.27
	669	460-18-1	1.12	12.27	31.25	3.25	5.84	150	147	Yellow	Dark Red-Brown	65	0.24
Di(2-ethylhexyl) Sebacate + 5% Methylene Iodide	627	460-18-2	0.327	11.83	15.33	3.20	3.67	157	151	Yellow	Black	66	0.40
	670	460-18-2	1.14	11.83	29.40	3.20	5.69	157	146	Yellow	Deep Red-Brown	66	0.24
Di(2-ethylhexyl) Sebacate + 5% Dichlorobiphenyl	628	460-18-3	0.327	13.17	26.16	3.37	5.67	150	149	Amber	Amber	66	1.19
	671	460-18-3	1.14	13.17	328.50	3.37	37.70	150	145	Amber	Light Brown	66	1.02
Di(2-ethylhexyl) Sebacate + 5% Bromoform	629	460-19-1	0.332	11.75	18.63	3.13	4.23	144	152	Amber Yellow	Black	66	0.69
	672	460-19-1	1.16	11.75	77.70	3.13	12.23	144	137	Amber Yellow	Black	66	0.55
Di(2-ethylhexyl) Sebacate + 5% Bromobenzene	630	460-19-2	0.332	11.17	18.75	3.07	4.25	156	151	Amber	Black	67	0.80
	673	460-19-2	1.16	11.17	71.40	3.07	11.50	156	137	Amber	Black	67	0.55
Di(2-ethylhexyl) Sebacate + 2% Iodobenzene	631	460-19-3	0.337	12.37	16.70	3.2	3.90	133	158	Yellow Amber	Yellow Amber	67	0.38
	701	460-19-3	1.18	12.37	59.00	3.2	9.43	133	132	Yellow Amber	Light Brown	67	0.42
Di(2-ethylhexyl) Sebacate + 8% Iodobenzene	633	460-20-1	0.337	10.90	14.35	3.00	3.50	164	143	Amber	Black	68	0.38
	675	460-20-1	1.18	10.90	25.80	3.00	5.20	164	140	Amber	Black	68	0.22
Di(2-ethylhexyl) Sebacate + 5% p-Fluoroanisole	634	460-20-2	0.342	10.47	19.55	2.93	4.43	159	157	Amber	Amber	69	1.00
	676	460-20-2	1.19	10.47	123.00	2.93	16.08	159	130	Amber	Dark Yellow	69	0.72
Di(2-ethylhexyl) Sebacate + 10% n-Butyl Borate	636	460-20-3	0.342	9.87	Solid	2.80	Solid	148	-	Amber	-	69	-
	677	460-20-3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	148	-	Amber	Black	69	-
Di(2-ethylhexyl) Sebacate + 16% Iodobenzene	678	460-25-1	0.356	9.15	14.40	2.67	3.47	149	133	Amber	Black	68	0.67
	684	460-25-1	1.45	9.15	47.1	2.67	7.766	149	134	Amber	Black	69	0.35
Di(2-ethylhexyl) Sebacate	679	460-25-2	0.328	12.93	25.8	3.37	5.37	158	150	Amber	Light Amber	66	1.11
	685	460-25-2	1.35	12.93	438.0	3.37	45.95	158	127	Amber	Dark Amber	65	0.85
Solvent Refined Western Paraffinic Lube Oil (150 N) + 20% 1-Methyl Naphthalene + 5% Dialkyl Selenide + 8% Iodobenzene, Blend Saturated with Quinizarin	680	460-25-3	0.334	13.05	18.45	3.03	3.70	110	93	Reddish Brown	Dark Brown	67	0.42
	686	460-25-3	1.35	13.05	50.73	3.03	6.83	110	98	Reddish Brown	Very Dk. Brown Vy.	65	0.28
Octadecylbenzene + 2% Iodobenzene	702	460-26-1	0.334	10.63	13.77	2.70	3.20	104	106	Water White	Black	67	0.39
	687	460-26-1	1.37	10.63	24.40	2.70	4.72	104	127	Water White	Black	66	0.17
Poly(propene oxide)-B Saturated with N,N'-Diphenyl-p-phenylenediamine	682	460-26-2	0.339	21.40	26.60	4.67	5.25	139	140	Dk. Reddish-Brown	Dk. Reddish-Brown	67	0.22
	688	460-26-2	1.37	21.40	70.20	4.67	9.70	139	120	Dk. Reddish-Brown	Dk. Reddish-Brown	66	0.20
Poly(propene oxide)-B + 2% Phenyl α-Naphthyl Amine	683	460-26-3	0.339	20.70	29.70	4.60	5.67	137	140	Reddish-Brown	Reddish-Brown	68	0.38
	689	460-26-3	1.39	20.70	75.90	4.60	9.99	137	118	Reddish-Brown	Dk. Red-Brown	66	0.21
Cetane	690	460-27-1	0.344	3.07	4.35	1.2	1.57	-	115	Water White	Water White	69	0.64
	695	460-27-1	1.41	3.07	21.18	1.2	4.77	-	162	Water White	Pale Yellow	67	0.61
Specially Treated Solvent Refined Western Paraffinic Lube Oil (150 N) lubricating	707	460-27-2	0.344	17.60	32.13	3.93	5.90	137	135	Light Amber	Reddish-Brown	69	0.79
	698	460-27-2	1.39	17.60	400.00	3.93	37.95	137	120	Light Amber	Deep Red-Brown	67	0.68
Specially Treated Solvent Refined Western Paraffinic Lube Oil (150 N) + 2% Dialkyl Selenide	713	460-27-3	0.347	17.53	27.60	3.83	5.30	123	136	Light Amber	Amber	66	0.57
	715	460-27-3	1.45	17.53	557.4	3.83	50.15	123	123	Light Amber	Dark Red	69	0.72

(?) single rule lubricating

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TABLE ~~V~~ 5/-1

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EFFECT OF THE IODOBENZENE CONCENTRATION ON THE RADIATION DAMAGE TO DI(2-ETHYLHEXYL)SEBACATE SAMPLES EXPOSED IN ~~THE~~ X-10 PILE

double rule

single rule

Iodobenzene Concentration, % ~~Per Cent~~ by Weight	note ~~Notebook~~ Reference	~~Ampoule~~ No.	Batch No.	Dosage (N), Neutrons/cm² $\times 10^{-18}$	A_{58} 1 Week	A_{58} 4 Weeks	Exposure Temperature °C
0	460-25-2	679	18A	0.328	1.11		66
0	460-25-2	68[illegible]	18B	1.35		0.85	65
0.5	258-40-1	565	17A	0.402	1.15		122
0.5	258-40-1	566	17B	1.52		Solid	104
1	258-39-1	561	17A	0.402	0.773		121
1	258-39-1	562	17B	1.48		1.045	58
2	758-39-3	[illegible]	17A	0.329	0.641		58
2	758-39-3	[illegible]	17B	1.52		1.012	106
4	758-39-2	[illegible]	17A	0.402	0.600		122
4	[illegible]	[illegible]	17B	1.48		0.716	101
5	[illegible]	[illegible]	18A	0.322	0.38		63
5	[illegible]	[illegible]	18B	1.12		0.27	65
8	460-20-1	[illegible]	18A	0.337	0.38		68
8	460-20-1	[illegible]	18B	1.18		0.22	68
16	460-25-1	678	18A	0.358	0.67		68
16	460-25-1	684	18B	1.45		0.35	69

single rule

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TABLE ~~VI~~ 6/-1

IDENTITIES OF SAMPLES IN BATCH 20 (180°C) AND BATCH 21 (220°C) FOR STATIC EXPOSURE IN X-10 PILE AT ABOUT 85% MAXIMUM FLUX FOR ONE MONTH

double rule

single rule

	Identity	Batch 20 (180°C)		Batch 21 (220°C)	
		Notebook Reference	Ampoule No.	Notebook Reference	Ampoule No.
1.	Alkylbenzene (MW≈350) + 2% Dialkyl Selenide	583-11-1	720	583-16-1	723
2.	Poly(propene oxide) SL-126 + 5% Dialkyl Selenide + 2% Iodobenzene, Blend Saturated with Quinizarin	583-11-2	713	583-16-2	725
3.	Didecyl Terephthalate + 2% Dialkyl Selenide	583-11-3	717	583-16-3	708
4.	Octadecylbenzene + 5% Dialkyl Selenide + 2% Iodobenzene, Blend Saturated with Quinizarin	583-12-1	712	583-17-1	716
5.	Di(2-ethylhexyl) Sebacate + 2% Dialkyl Selenide	583-12-2	719	583-17-2	722
6.	Di(2-ethylhexyl) Sebacate + 5% Dialkyl Selenide + 2% Iodobenzene + 20% 1-Methylnaphthalene, Blend Saturated with Quinizarin	583-12-3	718	583-17-3	721
7.	Alkylbenzene (MW≈250) + 4% Poly(lauryl methacrylate) + 2% Dialkyl Selenide	583-13-1	704	583-18-1	710
8.	Dow Corning Silicone 703	583-13-2	703	-	-
9.	Alkylbenzene (MW≈250)	583-13-3	702	583-18-3	714
10.	Amylbiphenyl	583-15-1	715	583-19-1	724
11.	Octadecylbenzene + 5% Dialkyl Selenide + 2% Iodonaphthalene, Blend Saturated with Quinizarin	-	-	583-18-2	709

single rule

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TABLE ~~VII~~ 7/—1

IDENTITIES OF SAMPLES OF BATCH 22 FOR STATIC EXPOSURE IN HANFORD PILE

double rule

single rule

Identity	Container No.	Wt. of Oil, ~~Grams~~ g
Poly(propene oxide) SL-11	F-51 F-52	7.4 7.4
Alkylbenzene (MW ≅ 250) + 4% Poly(lauryl methacrylate) + 2% Dialkyl Selenide	F-53 F-54	6.9 6.9
Didecyl Terephthalate + 2% Dialkyl Selenide	F-55 F-56	8.1 8.1
Poly(propene oxide)-B + 5% DialkylSelenide + 2% Iodobenzene, Blend Saturated with Quinizarin	F-57 F-58	6.3 6.3
Alkylbenzene (MW ≅ 350) + 2% Dialkyl Selenide	F-59 F-60	7.7 7.7
Di(2-ethylhexyl) Sebacate + 20% 1-Methylnaphthalene + 5% Dialkyl Selenide + 2% Iodobenzene, Blend Saturated with Quinizarin	F-61 F-62	7.5 7.5

Wt of oil, g

single rule

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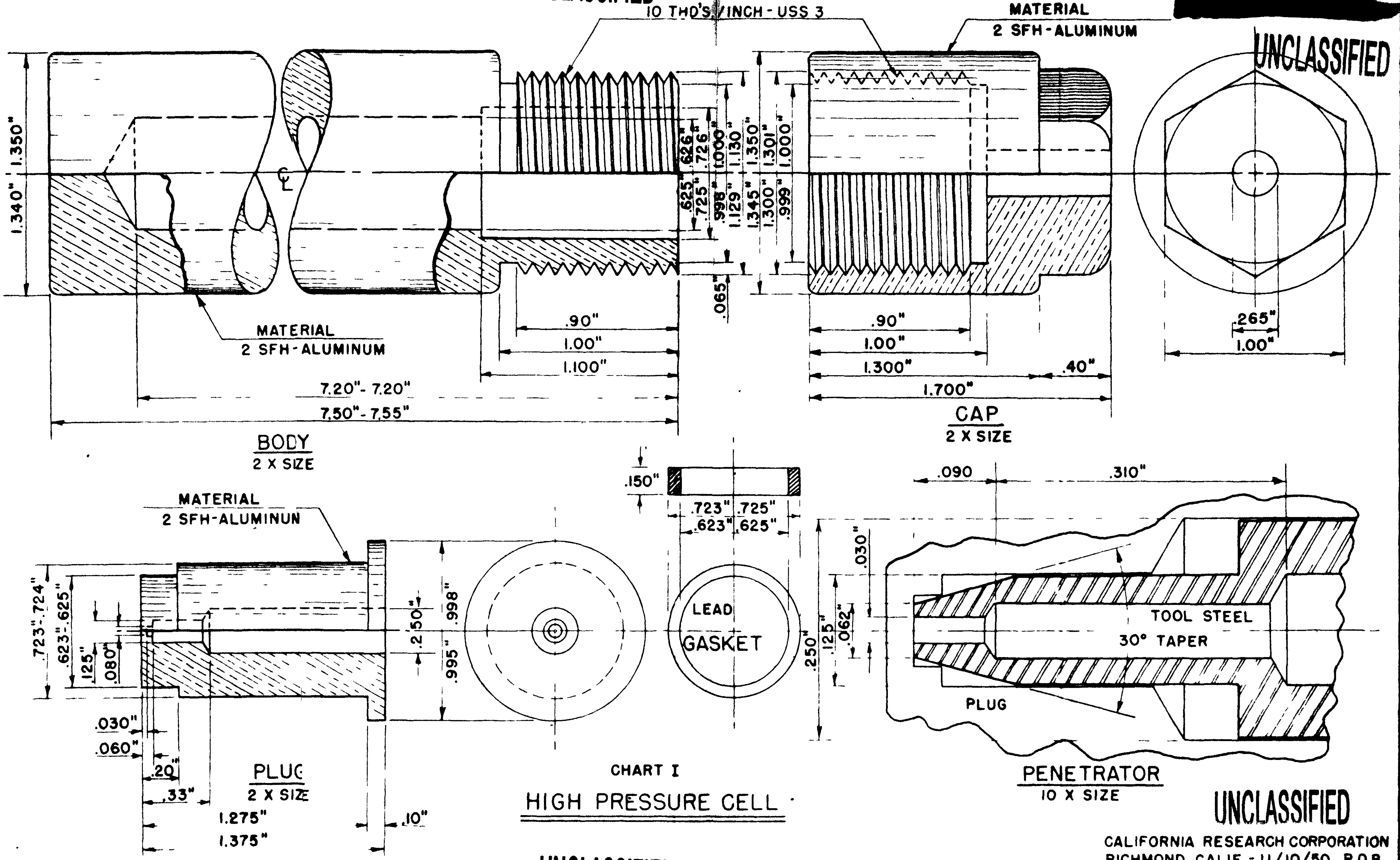

CHART I

HIGH PRESSURE CELL

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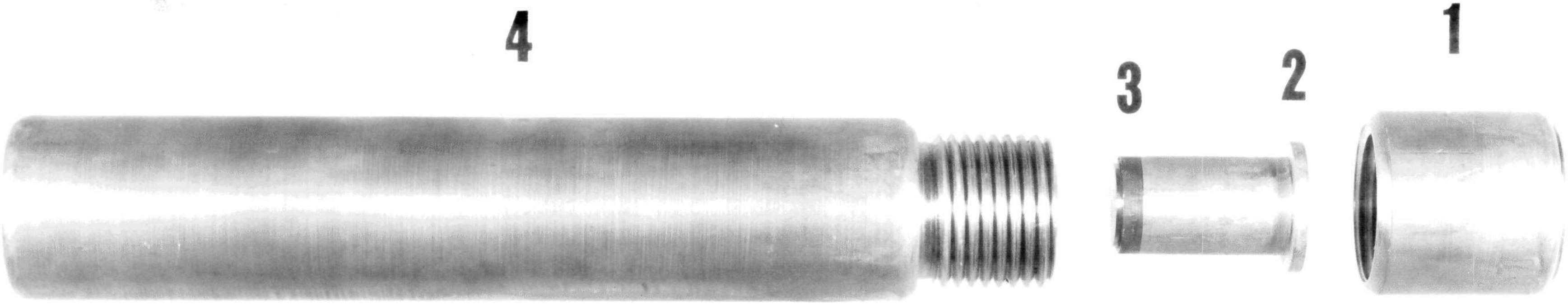
HIGH PRESSURE CELL

MATERIAL - 2 SFH - ALUMINUM



<u>NOMENCLATURE</u>

1. CAP
2. PLUG
3. LEAD SEAL RING
4. BODY

Y-237-16