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16. Abstract The idea of replacing part of an asphalt binder with sulfur is quite old, and documented techniques to do this date at least to the 1930's. However, Southwest Research institute in San Antonio, Texas (under sponsorship of the Federal Highway Administration) developed a family of binders which is composed entirely of sulfur and plasticizing agents-without asphalt. Using their plasticized sulfur binder, in 1978 SwRI personnel placed a 600-foot SULPHLEX hot-mix test section on a street at their facility.

Desiring a full scale field test, the FHWA contracted with the San Antonio District of the State Department of Highways and Public Transportation to place about one and one-half miles of Sulphlex hot-mix on FM 1604. A Type "D" AC-20 hot-mix control section was placed on August 25, 1980, and several sections of Sulphlex hot-mix were placed the following day. All design, production and placement was accomplished with standard, unaltered hot-mix equipment, except that provisions had to be made to minimize the objectionable odors in the laboratory. And the technicians who prepared the design mixes had to use auxiliary air supplies like those used in the mining industry. The Texas Air Control Board monitored emissions of H_2S, SO_2, and solvents at the batch plant and at the laydown machine. They found concentrations for all to be well below critical levels.

The production and placement of Sulphlex hot-mix presented no significant problems, but there was a noteworthy difference between the workability of the mixes: the Sulphlex hot-mix stayed tender longer than the asphaltic hot-mix. This made it necessary for the contractor to delay rolling with the pneumatic roller for about twenty minutes.

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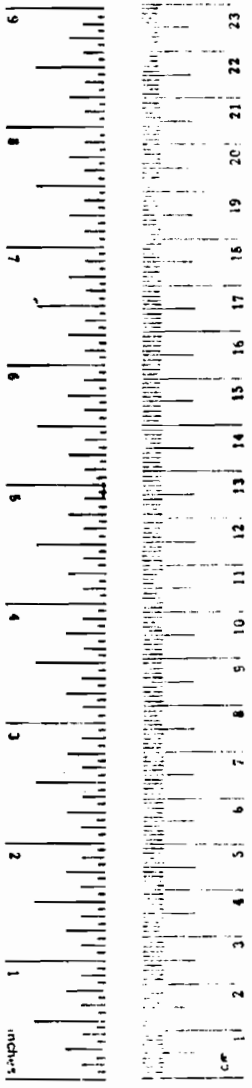
METRIC CONVERSION FACTORS

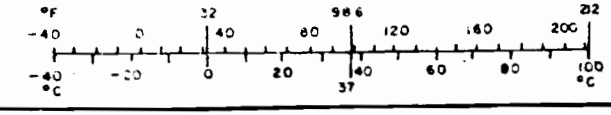
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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INTRODUCTION

Sulfur, an element which was known to the ancients, has long been recognized for its chemical and physical properties. In 1938, Isaac Bencowitz and E. S. Boe described a method of preparing a sulfur-asphalt binder by mixing the two materials together with a stirrer before mixing them with aggregate.[1] More recently, highway engineers have designed asphalt-sulfur binders which were produced with devices as simple as a mechanical stirrer or as sophisticated as the colloidal mill. In these projects, a portion of the sulfur was considered to be an asphalt extender or replacement for part of the asphalt.

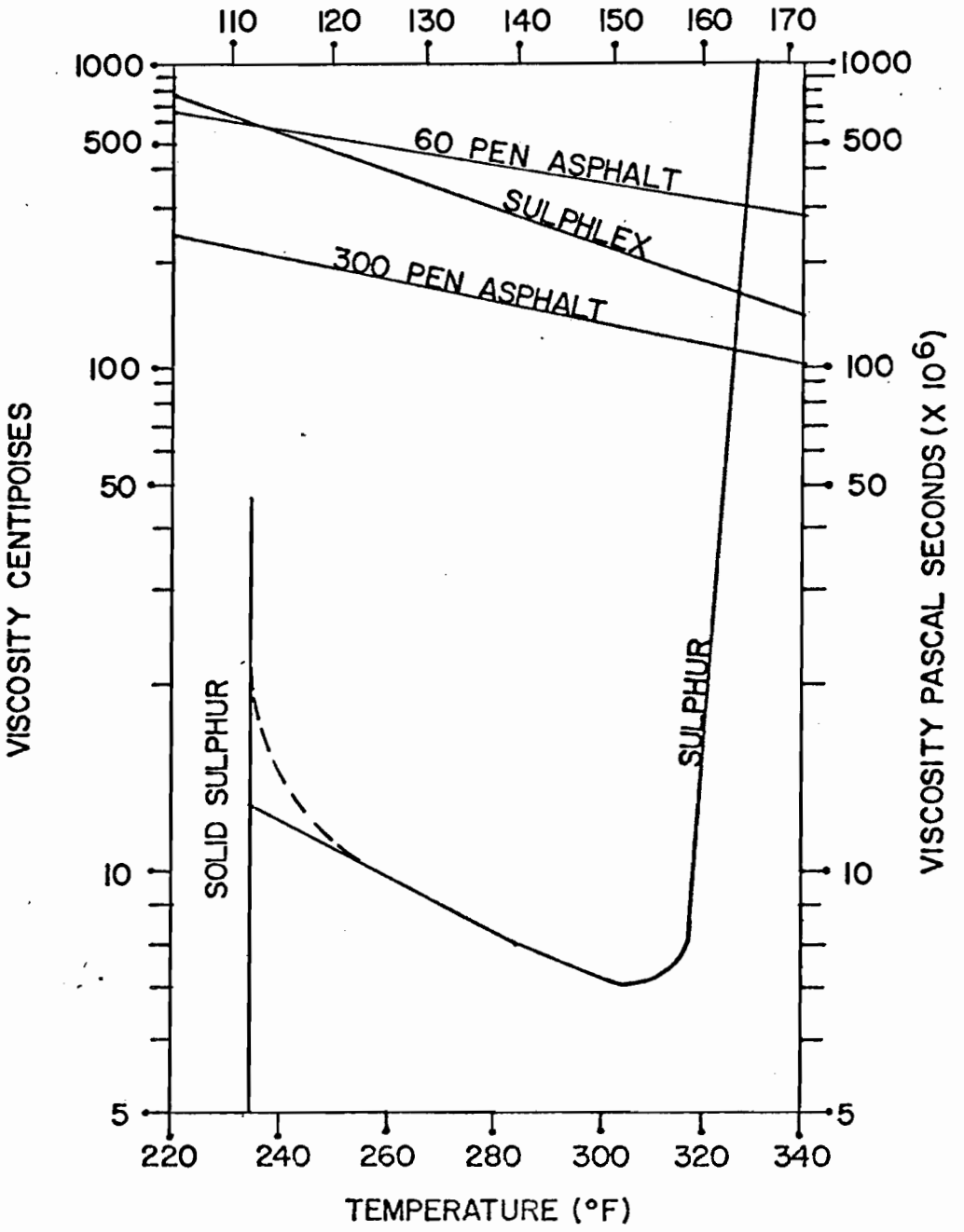
Elemental sulfur as an engineering material possesses high strength, but it is extremely brittle and frangible, so its use is limited to some very specialized applications. Of the three allotropic forms of sulfur which are of practical interest at room temperatures (orthorhombic, polymeric, and monoclinic), polymeric sulfur has the most desirable physical properties for use as a highway binder. Polymeric sulfur is formed by quickly quenching elemental sulfur which has been heated above 130° centigrade; but it rapidly reverts to the brittle crystalline form, particularly under stress.[2]

Southwest Research Institute (SwRI) in San Antonio, Texas started an active program in sulfur product development in 1959. And in the mid-seventies they undertook the specific project of chemically modifying elemental sulfur to improve its engineering properties for the purpose of providing: (1) a binder to serve as a replacement for asphalt in flexible paving mixtures and (2) a binder to serve as a replacement for Portland cement in rigid paving mixtures.[3] The objective was to develop a system to modify sulfur so that it would serve as the <u>total</u> binder in paving mixes, not just as an additive or asphalt extender.

For flexible paving mixtures, the researchers at SwRI sought to chemically modify sulfur such that it would retain, indefinitely, some of the desirable characteristics of polymeric sulfur. The resultant plasticization process was one with which they could stabilize polymeric sulfur by reacting it with non-petroleum-derived chemical hydrocarbons. The materials were formulated to have temperature-viscosity curves similar to asphalt cement, but they were distinctly different from those of elemental sulfur (See Figure 1).

In their search for a binder for flexible pavements, the researchers prepared over 500 formulations, narrowed the field to the 21 most promising, and then selected three for further testing. And, while these Sulphlex binders were formulated (1) to have engineering properties similar to asphalt and (2) to replace asphalt in paving mixtures, they had to be considered, not as a mimic of asphalt, but as a completely distinct family of binders. The empirical knowledge of asphalts simply could not be relied on to judge the characteristics and performance of Sulphlex.

In December 1978, SwRI personnel placed a 600-foot section of Sulphlex hot-mix pavement on a street at their San Antonio facility. Thus, it was demonstrated that Sulphlex could be prepared in large quantities and that



TEMPERATURE-VISCOSITY CURVES

FIGURE 1
(from Reference 3)

it could be substituted directly for asphalt. At this point, Federal Highway Administration officials felt that actual field testing on a heavily traveled public highway was needed to properly assess the long-term performance characteristics of Sulphlex hot-mix. So, through an experimental projects agreement with the Office of Research of the FHWA, the San Antonio District of the State Department of Highways and Public Transportation contracted to (1) design and place both a Sulphlex hot-mix overlay and a typical asphaltic concrete overlay control section, (2) demonstrate the design, production, and placement techniques to state, city, Federal and industry representatives, and (3) conduct extensive testing and evaluation of the material. The control pavement was placed on August 25, 1980, and the demonstration of the placement of the Sulphlex hot-mix was done on August 26, 1980. Richard H. Magers, Supervising Laboratory Engineer for the San Antonio District, was the study supervisor and engineer for the project.

DESIGN OF SULPHLEX HOT-MIX

The site which was chosen for the project was on Loop 1604, the outer loop around the city of San Antonio. It was located between Bandera Road and Babcock Road in the northwest quadrant of the city, and it was just west of the entrance to the University of Texas at San Antonio. In addition to prerequisite engineering considerations, the site was appropriate because of its proximity to the hot-mix plant which was to be used, to Southwest Research Institute, and to the San Antonio District Office of the State Department of Highways and Public Transportation.

The original roadway was constructed in 1961, and it consisted of eight inches of flexible base and a two-course surface treatment. Then in 1970, this was overlaid with one inch of hot-mix asphaltic concrete (See Figure 2).

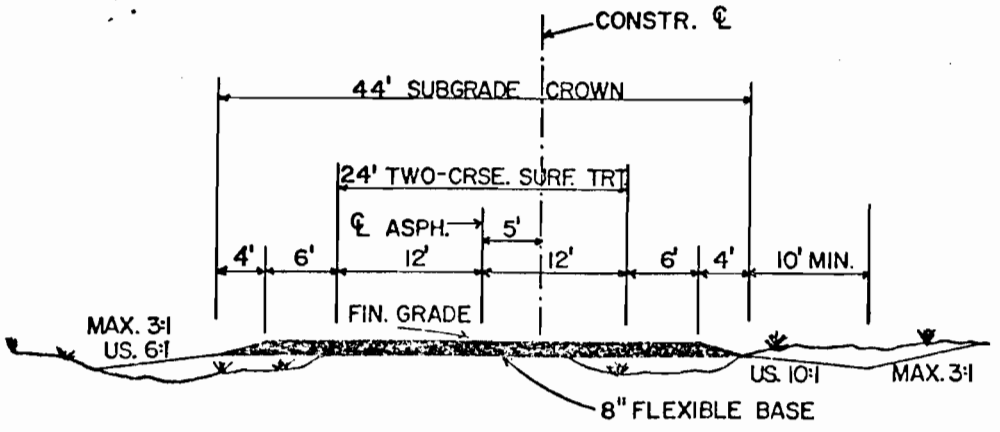


Figure 2
Roadway Profile

NOTE In 1970, a 1" overlay was added, for a total depth-of-section of 9".

A traffic count and analysis showed the average daily traffic (ADT) to be 5600 with 9.3% trucks and an average of the ten highest wheel loads (ATHWLD) of 12,300 with 60% tandem axles. The pavement had begun to flush and rut in some areas.

Considering the type and condition of the existing pavement and the ADT and types of vehicles, 100 lbs./sq. yd. (approximately one inch) of Texas' standard Type "D" hot-mix overlay would typically be placed. Additionally, background data (which are contained in Appendix A) such as soil characteristics, evaluation of the flexible base, average temperatures, and deflection tests supported the estimate that one inch of both HMAC control and of Sulphlex overlay would be adequate.

The researchers and engineers ultimately decided to use Sulphlex formulation No. 233A, which consisted of the following:

68% sulfur (S)

12% dicyclopentadiene (DCPD)

10% vinyl toluene (VT)

10% Solvenol 2

The choice was based on the fact that Sulphlex 233A compared favorably with AC-20 (an asphalt which is commonly used in Texas hot-mixes and the one selected for the control overlay) and the fact that the chemical components were readily available in the quantities needed for this job. A different formulation with comparable characteristics had been considered first but had to be rejected because one of the constituents was not available. Fortunately, personnel at SwRI were able to design Sulphlex 233A to have similar engineering properties using somewhat different chemicals from different commercial suppliers. Further, they anticipated that in future jobs, it would sometimes be possible to alter the types and amounts of the various constituents sufficiently to allow the use of locally (or regionally) available chemicals, thus avoiding having to ship materials long distances.

The San Antonio District (District 15) of the State Department of Highways and Public Transportation typically designs Class A hot-mix asphaltic concrete pavement by Texas Specification Item 340, as amended by Special Provision 340...102 (contained in Appendix B). So this specification was used for the design and placement of the Sulphlex hot-mix also.

Initially, three coarse aggregate types were considered: a sandstone, a traprock, and a limestone. However, our standard stripping test, Test Method Tex-218-F (which is an estimate of asphalt loss to a coated aggregate sample which has been subjected to agitation in water), revealed a possible susceptibility to stripping in the traprock/Sulphlex combination. A 20% loss of coating was estimated in the limestone and sandstone samples, but a 50% loss was estimated in the traprock sample. Even though this was an empirical test which was based on asphalt cements, it was felt that the possibility of stripping in the traprock/Sulphlex combination was significantly greater than that in the other two samples.

Choosing to use both limestone and sandstone, the Supervising Laboratory Engineer combined four materials in order to meet the gradation requirements shown on page 3-9 of the Special Provision to Item 340: 27.5% field sand, 7.0% limestone screenings, 22.5% intermediate coarse aggregate (limestone), and 43.0% coarse aggregate (sandstone).

The procedures, equipment, and techniques which were used in the design of Sulphlex hot-mix were exactly the same as those used for HMAC, with the exception of some safety considerations which will be discussed later. However, since Texas used Hveem design methods and Southwest Research Institute had used Marshall stability and flow in the design of their December 1979 job, FHWA contact persons requested that trial batches be designed using both Hveem and Marshall techniques. This not only provided a worthwhile comparison between the two design methods, but it also provided data which were meaningful to other agencies which base their designs on Marshall stability. The Marshall stability and flow testing was done by SwRI (Appendix C).

Since the specific gravity of Sulphlex 233A was determined to be about one and one-half times the specific gravity of AC-20 (1.53 vs 1.02), the percentages of binder, by weight, for the Sulphlex test specimens ranged from 7.0% to 9.5% while the percentages for the asphalt specimens ranged from 4.0% to 7.0%. From the Density-Stability Curves, optimum binder contents were considered to be 4.7% for AC-20 and 7.0% for Sulphlex 233A. Further, these percentages, by weight, represented almost equal volumes of binders. But when 7.0% mixes were prepared, they looked a little dry, so the engineer decided that it would be practical to place sections using 7.0%, 7.5% and 8.0% Sulphlex. Appendix D contains the mix designs and density-stability curves.

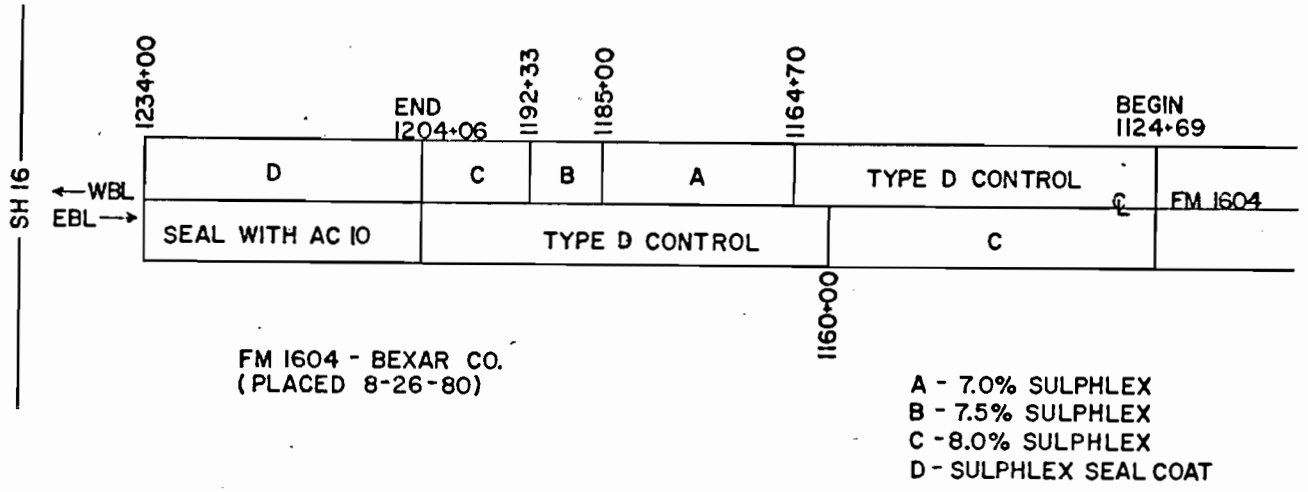
An extra set of Hveem test specimens was made for analysis by the Materials and Tests Division in Austin. Using 50X magnification, the geologist counted air voids and estimated that the 7% mix contained 6-1/2 to 7 percent air voids and that the 8% mix contained 4 to 4-1/2 percent air voids.

Sulphlex 233A had such a strong, penetrating odor that it was necessary to move the mix design operations into a mobile field laboratory behind the District laboratory building. (See Photograph 1).

The lab technicians wore self-contained breathing apparatuses (like those used in the mining industry) in order to have a continuing supply of fresh air. And after their families started complaining about the irremovable odors in their clothes, they started wearing white paper coveralls which they discarded every day or so. This helped to minimize the lingering odors of Sulphlex. Appendix E contains physical properties and safety data sheets for vinyl toluene, dicyclopentadiene, and Solvenol 2.

CONSTRUCTION

On the morning of August 25, 1980, the contractor began placing the first of two three-quarter mile control sections, one on the eastbound lane and one on the westbound lane such that alternating sections of Sulphlex hot-mix could be placed the following day. Production and placement of both mixes were done by maintenance contracts.



SULPHLEX TEST SECTION

FIGURE 3

The mix was produced at the McDonough Brothers plant about five miles from the job site. The plant was a 200 tons/hr. Cedarapids Batch Plant equipped with an 88-in. by 28-foot dryer. This was the plant where the Sulphlex mix had been produced for the 600-foot test section at Southwest Research Institute.

The contractor shot 0.02 to 0.06 gal./sq. yd. of RC-2 tackcoat and squeegeed it with an empty nine-wheel medium pneumatic roller. Then he placed the Type "D" control mix with a Barber-Green SB-111 laydown machine. A Tampo RS-144A (10,600 lbs. static weight) dual drum vibratory roller was used for breakdown, and it was followed by a 12-ton Tampo pneumatic roller, Model SP-312. Temperature of the mix at the plant was approximately 270° F and the temperature of the mat was about 225° F.

On the following day, August 26th, a meeting was held with representatives from several cities, nine states, many technical institutions, the Federal Highway Administration, and several commercial organizations. Dr. Gerald Love spoke briefly about the Federal Highway Administration's role in the development and testing of Sulphlex. Then Mr. John Dale, of Southwest Research Institute, provided a summary of their work in the development of Sulphlex. Following a short discussion, questions and answers, the attendees were bussed to the batch plant and then to the project site to observe the placement of the Sulphlex hot-mix.

The Sulphlex mix was batched and placed with the same standard, unaltered equipment and techniques as had been used on the control mix the previous day. There were three obvious differences, however. First, the Sulphlex mix emitted green smoke which had the characteristic penetrating odor. Second, the color of the mix was a deep chocolate brown; and third, the Sulphlex mix tended to stay tender slightly longer than asphaltic hot-mix.

After the engineer noticed that the pneumatic roller was tracking the mat, he decided to hold it back 20 to 30 minutes behind the lay-down machine. Temperature of the Sulphlex at the plant was about 275^{0} F, and the 7% Sulphlex mat averaged about 220^{0} F, the 7-1/2% Sulphlex mat averaged about 240^{0} F and the 8% mat averaged about 250^{0} F.

The Troxler Nuclear Density Device was used to measure densities immediately behind the breakdown roller, prior to the pneumatic roller being placed on the mat. The densities (which averaged 97% of lab density) were used to establish a rolling pattern (Appendix F).

The weather was hot and dry during both days of construction, with temperature extremes ranging from 68° F to 96° F and an average of about 83° F. It should be noted that even though the National Weather Service reported 0.27 in. of precipitation at the weather station on August 25th, none was observed at the project site. Appendix G contains an annual summary of the Local Climatological Data, as well as Local Climatological Data for the month of August, 1980.

One of our main concerns from the beginning of this project was the green smoke which emanated from the Sulphlex mix. The odor was rather objectionable and it irritated our eyes and nasal passages. So, air quality control experts were requested to monitor the emissions from the mix, both at the plant and on the job. Personnel were on hand from the Texas Air Control Board and the San Antonio Metropolitan Health District. They monitored hydrogen sulfide, sulfur dioxide, and solvents and found that all were well below critical levels. Figure 4 shows typical effects to humans for various concentrations of hydrogen sulfide and sulfur dioxide. These values are based on references which were available to the Texas Air Control Board as of March 31, 1982.

The concentration of SO_2 two feet from the laydown machine was 0.622 ppm; at 200 feet downwind, it was 0.021 ppm. Concentration of H_2S two feet from the laydown machine was 3.64 ppm, and at 200 feet downwind it was 0.0008 ppm. Appendix H contains the Air Pollution Sample Report containing the H_2S and SO_2 concentrations at the job site and the results of the TACB laboratory analysis showing concentrations of Solvenol 2, vinyl toluene, and dicyclopentadiene at the plant.

The Sulphlex 233A was manufactured in Odessa, Texas by Chemical Enterprises, Inc. The trucks which were used to transport it were standard, insulated asphalt transfer trucks. Two of the trucks made the 350-mile trip on August 25th, and the third truck made the trip the following day. It was estimated that the temperature of the Sulphlex at the beginning of the trip was around 200° F; and by the time of arrival at the McDonough Brother hot-mix plant, load No. 1 was 140° F, load No. 2 was 175° F and it was estimated that load No. 3 was also around 175° F.

The material was so viscous that it could not be unloaded, so the trucks were put on steam. Both were brought up to 260° F before off-loading to the storage tanks at the hot-mix plant. Load No. 3 was put on steam until it was needed at the plant on the afternoon of August 26th. So, instead of off-loading into the storage tanks, it was pumped from the tank truck directly to the pug mill as needed. Appendix I contains a viscosity-temperature graph for the three loads of Sulphlex.

TOXICITY OF SO_2

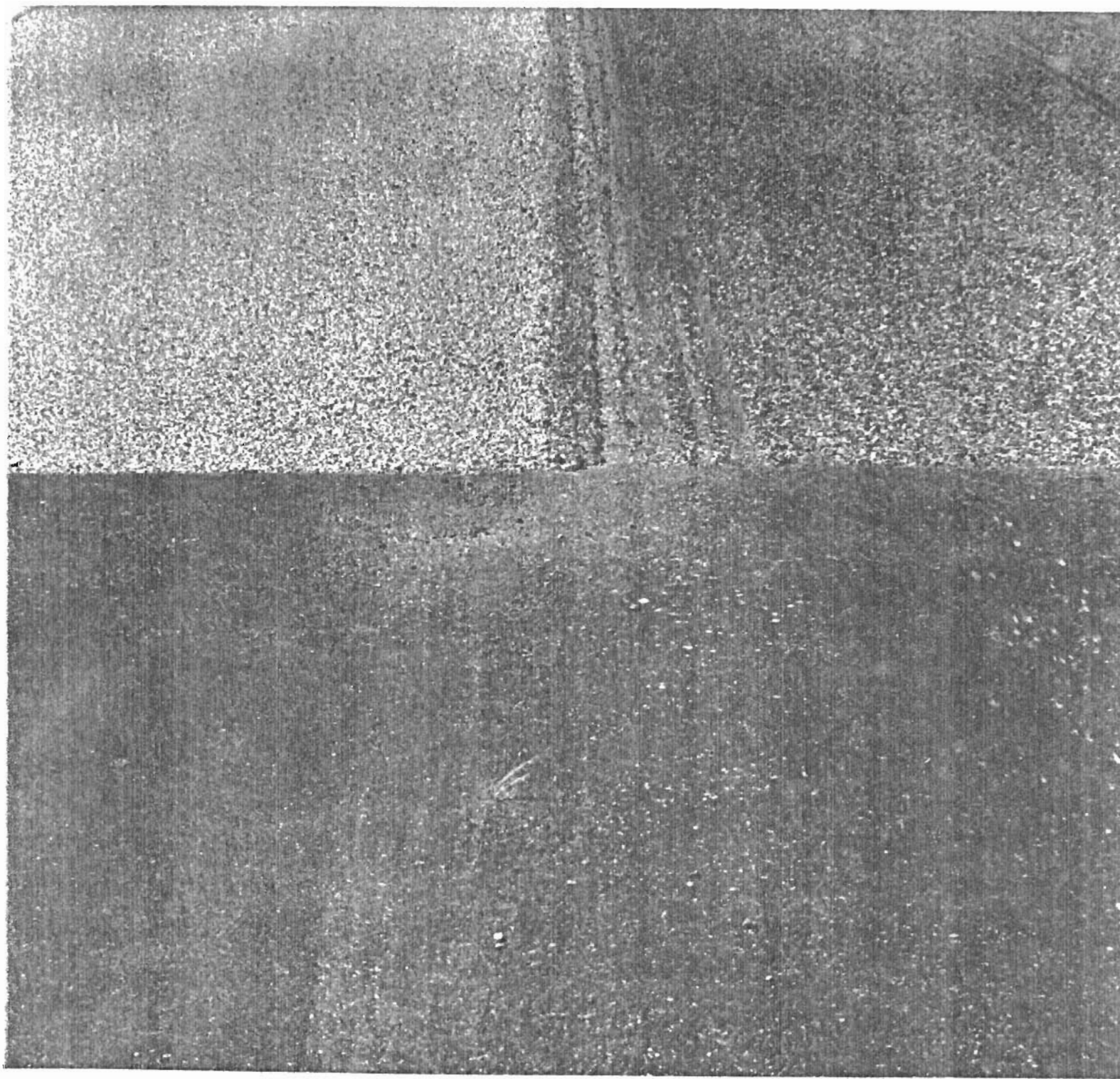
Concentration (ppm)	Effect
0.3-1	Detected by taste (some people will notice odor and experience irritation at 0.5 to 0.7 ppm)
2	Threshold Limit Value (TLV) for 8 hours of exposure per day for 5 days
3	Noticeable odor
6-12	Immediate irritation of nose and throat
20	Irritation to eyes

TOXICITY OF H_2S

Concentration (ppm)	Effect
0.02	Odor threshold ("rotten egg" odor)
3-4	Eye irritation
10	Threshold Limit Value (TLV) for 8 hours of exposure per day for 5 days
20-50	Respiratory irritation, coughing
170-300	Maximum concentration which can be inhaled for one hour without serious consequences

Figure 4

There was enough binder left in the third transport to shoot a short penetration chip seal test section. This remaining Sulphlex was put back on steam until Friday, August 29th when the work could be performed. Approximately 1300 feet of Sulphlex seal (using Grade 3 precoated rock) was placed in the westbound lane, abutting the 8% Sulphlex hot-mix section. And a Grade 4 non-precoated sandstone AC-10 (control) seal coat was placed adjacent to the Sulphlex seal coat in the eastbound lane



TESTING

Before and after testing for this project consisted of the following:

1. Visual examination (team concept) including evaluation of rutting, raveling, cracking, and stripping
2. Mixture stabilities and flows
3. Mixture resilient modulus
4. Mixture densities and void contents
5. Indirect tension
6. Fatigue
7. Dynaflect
8. Vertical photologger
9. Mays Meter
10. Skid testing

Texas State Department of Highways and Public Transportation uses a somewhat standardized pavement evaluation form, and copies of the before construction evaluations are in Appendix J. They show the pre-construction roadway to have had moderate cracking, rutting and flushing in some areas. No stripping of the asphalt was observed.

Marshall stabilities and flows were run on mix design specimens by personnel at Southwest Research Institute, but the results are not available at this time. It is anticipated that stabilities and flows on the plant mix and/or on cores taken from the roadway are being run by Texas Transportation Institute. They are not available at this time.

Mixture resilient moduli were not obtained on specimens of the mix from the plant, but TTI personnel are determining resilient moduli on cores from the roadway.

Mixture densities and void contents were run on specimens which were made from samples taken from the plant. The control HMAC specimens averaged 94.8% density and 5.2% voids. Hveem stabilities were also run on the control and found to average 49. Density of the Sulphlex 233A specimens averaged 97.2% with 2.8% voids. Hveem stability of the Sulphlex specimens averaged 47.7. Appendix K contains the stability reports with the results of the individual tests.

Indirect tension and fatigue tests are also being run on core samples from the control and Sulphlex sections. This work is being done by TTI, but the results are not available at this time.

Dynaflect testing was conducted both before and after construction. The values before construction indicated that the existing pavement and subgrade were sufficiently strong to merit the placement of one inch of hot-mix overlay. Copies of the computer printouts with surface curvature index, stiffness coefficient of the subgrade and stiffness coefficient of the pavement are in Appendix L. It should be noted that the fourth set of readings in the before construction data, south (sic) direction of travel (actually southwesterly, at odometer reading 0.60) was taken over a culvert. The geophone readings indicated unusually high deflections, the stiffness coefficient of the subgrade was unusually low, and the stiffness coefficient of the pavement was high. These values should be discounted and new averages can be calculated without them if needed. As expected, the values after construction reflect a slightly higher stiffness coefficient of the pavement and little change in the stiffness coefficient of the subgrade.

The vertical photologger consists of a 35mm camera with a 24mm wide angle lens, a small trailer with a boom and a tow vehicle. The camera is mounted 8 feet above the roadway at the end of the boom and it is aimed vertically toward the pavement . The camera can be set to automatically trigger at any increment up to one mile as the trailer is towed down the roadway. Two-hundred ASA color positive film is used, and an area of approximately 8 ft. by 12 ft. is photographed in each frame. For this job, photographs were taken at approximately 50-foot intervals.

The processed, uncut transparencies are projected onto a screen which has a 10 x 10 grid on it; thus, each projected frame is divided into 100 parts. And each part (1/100 of the frame) is then examined for cracking pavement. For example, in the section where the 8.0% Sulphlex was to be placed, a crack was noted in 10 parts of one projection or one frame of film. There were a total of 24 frames (2400 possibilities) so it is reported as having 10/2400 x 100 = 0.42% cracking.

PHOTOLOGGING

Section	Before	After (9-3-80)
1124 + 69 to 1164 + 70 (Type "D" Control)	0%	0%
1164 + 70 to 1185 + 00 (7.0% Sulphlex)	0%	0%
1185 + 00 to 1192 + 33 (7.5% Sulphlex)	0%	0%
1192 + 33 to 1204 + 06 (8.0% Sulphlex)	0.42%	0%
1204 + 06 to 1160 + 00 (Type "D" Control)	1.33%	0%
1160 + 00 to 1124 + 69 (8.0% Sulphlex)	0%	0%

Figure 5

Mays Ride Meter testing was performed prior to construction on July 3, 1980. The average Serviceability Index (SI) value in the westbound direction was 3.7, and in the eastbound direction it was 3.1. No Mays Ride Meter testing has been done since construction because of equipment malfunctions.

Standard ASTM skid testing was performed before construction on July 3, 1980 and after construction on September 19, 1980. The results are in the following figure.

SKID TESTS

Before		After	
Westbound:	Low-21 Average-27 High-36	Westbound-Type "D" Control:	Low-27 Average-31 High-33
		Westbound-7%, 7.5%, 8.0% Sulphlex Comb.:	Low-35 Average-39 High-43
Eastbound:	Low-22 Average-26 High-30	Eastbound-Type "D"Control:	Low-29 Average-33 High-36
		Eastbound-8.0% Sulphlex	Low-34 Average-37 High-40

Figure 6

CONCLUSIONS

1. Sulphlex formulations (with characteristics similar to asphalt cement) can be produced in quantities sufficiently large to use in a major paving operation.

2. Sulphlex hot-mix can be produced in a typical, unaltered hot-mix batch plant, and it can be designed and placed with standard, unaltered equipment which is typically used for design and placement of asphaltic hot-mix.

3. No significant toxic symptoms from exposure to Sulphlex were experienced during this project; however, working in high concentrations in the laboratory while making mix design specimens necessitated the use of auxiliary air supplies.

4. Measured emissions during batching and placing of the Sulphlex hot-mix were well below maximum allowable concentrations.

5. The Sulphlex hot-mix which was placed on this job stayed tender slightly longer than the control asphaltic hot-mix.

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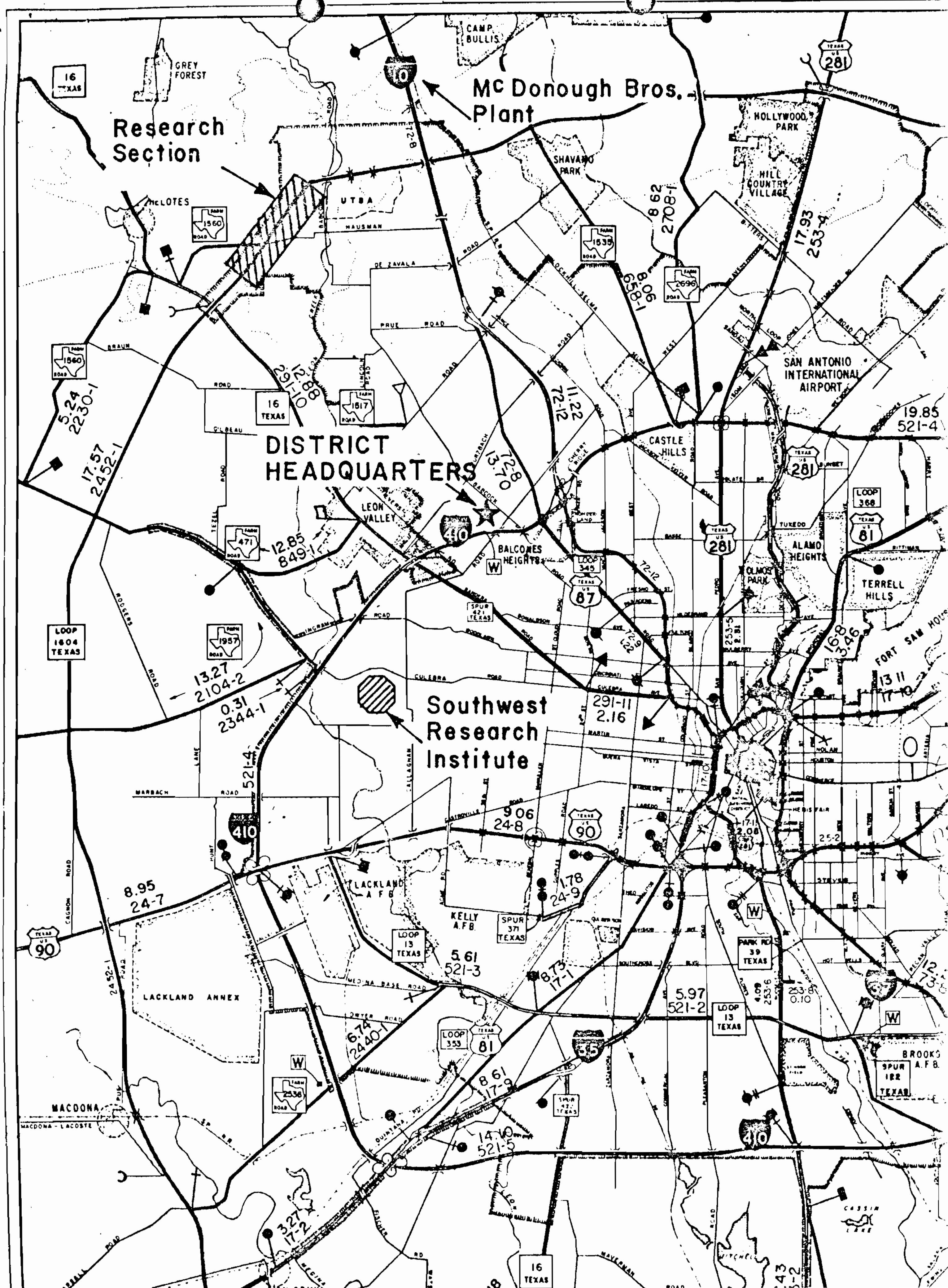
APPENDIX A


Mc Donough Bros. Plant
Research Section
DISTRICT HEADQUARTERS
Southwest Research Institute
CAMP BULLIS
GREY FOREST
HOLLYWOOD PARK
SHAVANO PARK
HILL COUNTRY VILLAGE
SAN ANTONIO INTERNATIONAL AIRPORT
CASTLE HILLS
LEON VALLEY
BALCONES HEIGHTS
ALAMO HEIGHTS
OLMOS PARK
TERRELL HILLS
FORT SAM HOUSTON
LACKLAND A F B
KELLY A.F.B.
LACKLAND ANNEX
BROOKS A.F.B.
MACDONA
UTSA
LOOP 1604 TEXAS
LOOP 13 TEXAS
LOOP 353
LOOP 368
SPUR 371 TEXAS
PARK RD 39 TEXAS
SPUR 122 TEXAS
16 TEXAS
8.62 2708-1
17.93 253-4
8.06 658-1
12.88 291-10
5.24 2230-1
17.57 2452-1
11.22 72-12
12.8 13.70
19.85 521-4
12.85 849-1
13.27 2104-2
0.31 2344-1
291-11 2.16
521-4
9.06 24-8
8.95 24-7
1.78 24-9
5.61 521-3
8.73 17-1
5.97 521-2
6.74 2440-1
8.61 17-9
14.10 521-5
3.27 17-2
13.11 17-10
16.8 3.46
17.11 2.08
253-8 0.10

Re: Sulphlex Test Section
General Geology

Location

The Subject Test Section is located in Northwest Bexar County on FM 1604 between SH 16 and IH 10, and immediately South of the Balcones Escarpment.

Climate

Bexar County is located between the arid southwest and the moist Coastal Plains. The annual mean temperature at San Antonio is about 70° F. The annual mean rainfall is about 29 inches.

Balcones Escarpment

The prominent topographic feature in the county is the Balcones Escarpment. Northwest of the escarpment, the country is at a higher elevation than to the southeast. The escarpment defines the larger faults of the Balcones Fault Zone.

Stratigraphy

Geologic formations mapped in the county are Mesozoic and Cenozoic in age. Formations adjacent to the test section Mid-Creataceous to late Cretaceous in age are the Edwards Limestone, Georgetown Limestone, Buda Limestone, and the Del Rio Clays and Shales. Lithologically, the Edwards consists of mostly crystalline limestone, thick bedded, dense, and containing considerable flint and/or chert.

The Georgetown is very similar to the Edwards, and is very difficult to differentiate between these two formations.

The Buda in this county is a very uniform fine grained, dense, hard limestone and is easily recognized due to its proximity to the softer sediments of the underlying Del Rio Sediments. The Del Rio formation outcrops in very thin narrow belts across the northwestern part of the county. The Del Rio clays are marly, calcareous and highly fossiliferous, having a characteristic index fossil.

Residual soils covering this portion of the county consists of stony clays and clay loams over limestone bedrock.

State Department of Highways and Public Transportation
Form 505 Rev. 7-78

SUMMARY OF FIELD ANALYSIS — SOILS AND BASE MATERIALS

From 7-21-80 19 to 19

Type of Contract Information Samples - Sulphlex Materials

Control No. | Section No. | Job No.

Contractor

Bexar (County) | 30-3-240-054415-807 (Federal Project No.) | Highway No.

Engineer Richard H. Magers

Estimate No. Tests Made by District Laboratory

Requisition No. (Maintenance Only) District No. 15

Material, Source and Lab. No. of Quality Tests

Material used as Existing Subgrade 0-6" depth Item No.

Locations shown below - Existing Subgrade

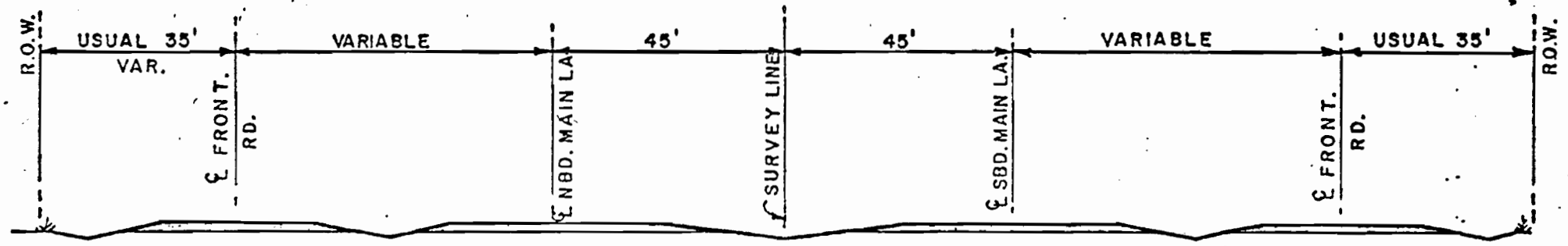
Identification Number	STATIONS REPRESENTED STATION TO STATION	Quant. Rep.	LL	PI	LS	SL	SR	Class	% Moist.	% RETAINED ON 2½"	1¾"	⅞"	⅜"		No. 4	No. 40	No. 200	REMARK
SHOW SPECIFICATION REQUIREMENT HERE																		
	Hole No.	Location																Date Sampled
15-80-1221	1	1150 + 00 ±		25	11	7.0	13	1.91			0	5	22		34	68		7-11-80
-1222	2			26	11	6.7	13	1.90			0	9	26		38	70		"
-1223	3			23	10	6.0	12	1.99			0	11	30		41	67		"
-1224	1	1176 + 00 ±		60	42	21.1	11	1.97			0	0	0		1	5		"
-1225	2			60	35	20.4	9	2.00			0	0	0		1	5		"
-1226	3			50	32	17.9	10	2.02			0	6	12		15	28		"
-1227	2	1202 + 00 ±		64	41	22.3	10	2.00			0	0	0		1	5		"
-1228	3			55	37	19.8	9	2.19			0	0	0		1	7		"
									15-80-1221,1222,1223 - 1½" HMAC, 8" Flex. Bs.									
									15-80-1224,1225,1226 - 1½" HMAC, 8" Flex. Bs.									
									15-80-1227,1228 - 1½" HMAC, 8" Flex. Bs.									

Richard H. Magers (2)
District Laboratory Files

Total Quantity for Period

NOTE: For Preliminary Investigations TWO copies of this form shall be submitted with plans.

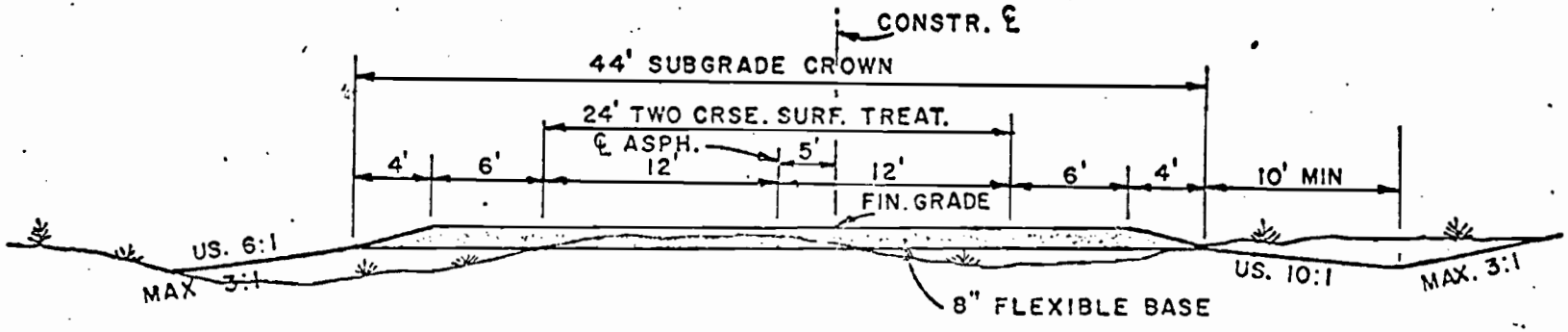
A-4



ULTIMATE SECTION

A-5

NOTE: This Project Was Completed In 1961. In 1970, A 1" Overlay Was Added, For a Total Depth Of Section Of 9".



TYPICAL SECTION

Re: Sulphlex Test Section
FM 1604 - Bexar
Evaluation of Existing Flexible Base Material

Attached are results of soil constants, wet ball mill, grading analysis, and quick triaxial strength tests at confined and unconfined condition on material sampled in proposed cut sections for the FM 1604 improvement project between Babcock Road and Leon Creek, presently under contract.

The material was crushed in the District Lab and prepared for testing as indicated above. The depth of material sampled is also shown.

Strength test results indicate this material exceeds the requirements for Grade 1 (Class I) Flexible Base material, and is similar to the Roadway Cut material crushed and placed on the FM 1604 project scheduled for the Sulphlex Test Section.

Texas Highway Department
Form 505

SUMMARY OF FIELD ANALYSIS — SOILS AND BASE MATERIALS

From July 16, 1975 19 to 19

Type of Contract Gr.,Strs.,Flexible Base & Asph. Surface | 2452 (Control No.) | 2 (Section No.) | (Job No.)

Contractor Design | Bexar (County) | 3-510 (Federal Project No.) | FM 1604 (Highway No.)

Engineer John D. Stockton | Estimate No. | Tests Made by District Laboratory

Requisition No. (Maintenance Only) | District No. 15 | Material, Source and Lab. No. of Quality Tests Limestone,Cal.Clay

Material used as Flexible Base | Item No. | Station No's Listed Below (Cr. In Lab. Crusher)

Identification Number	STATIONS REPRESENTED STATION TO STATION	Quant. Rep.	LL	PI	LS	SL	SR	Class	% Moist.	% RETAINED ON 2½"	1¾"	¾"	⅜"	No. 4	No. 40	No. 200	REMARKS
SHOW SPECIFICATION REQUIREMENT HERE																	Depth
	Station No.																
15-75-866	40' So. 58+00		23	6	6.6	11	1.98				0	31	50	56	69		0'-16'
-867	40' So. 67+00		24	6	4.8	15	1.85				0	37	56	62	71		0'-18'
-868	140' No. 67+00		24	7	5.3	14	1.89				0	31	53	61	74		0'-21½'
-869	40' So. 90+00		29	14	8.7	13	1.94				0	44	64	70	80		0'-20'
-870	140' Rt. 90+00		27	11	7.8	13	1.92				5	36	51	57	68		0'-21'
						Wet Ball Mill											
						Before		After									
			15-75-866			29.4		36.8									
			-867			29.2		38.9									
			-868			30.9		43.4									
			-869			20.7		29.6									
			-870			29.4		39.3									

15-75-971 (Average 15-75-867 & 868)
Average Strength 69.97 PSI at 0 pounds lateral pressure at 5.6% moisture.
Average Strength 227.71 PSI at 15 pounds lateral pressure at 5.6% moisture.

15-75-972 (Average 15-75-869 thru 870)
Average Strength 70.99 PSI at 0 pounds lateral pressure at 5.3% moisture.
Average Strength 200.73 PSI at 15 pounds lateral pressure at 5.3% moisture.

15-75-866 - Average Strength 47.18 PSI at 0 pounds lateral pressure at 6.0% moisture.
Average Strength 183.25 PSI at 15 pounds lateral pressure at 6.0% moisture.

Dist: Garrette Wilson
John D. Stockton
Total Quantity for Person
Dist. Lab.

NOTE:
For Preliminary Investigations TWO copies of this form shall be submitted with plans.

Placement of Sulphlex Pavement

(30-3-240-054415-807)

Location of Section:

FM 1604
Control 2452-2
From: Near Babcock Rd.
To: SH 16

Type Subgrade:
Red. brown, cherty, clay loam w/flaggy, broken, weathered fragments of limestone.

Texas Triaxial Strength Class = 3.0
Avg. Stiffness Coeff. AS_2 = 0.34
P.V.R. = Non critical
Approx. ADT = 4000 VPD
(Est) ATHWLD = 11,000 lbs. (50% Tandem Axles)
(Est) DATHWLD = 13,000 lbs.

Triaxial Coverage Req. for DATHWLD = 4"
" " " for 20,000 WL = 5"

Stiffness Coeff. 0.34 supports the very good Strength classification of the subgrade soil

Existing Pavement Structure:

ACP	1.00"
Cr. Ls. Flexible Base	8.00"
Total thickness	9.00"

Est. Triaxial Strength Class of Crushed Limestone Flexible Base = Class 2.5 or better. Equiv. to Ty A - Gr 2 Fl. Bs.

Stiff Coeff. AP_2 = 0.59
SCI = 0.257

Stiff. Coeff. AP_2 & SCI Value Supports the Indicated Triaxial Strength Class of the Flexible Base.

Re: Sulphlex Test Section
FM 1604 - Bexar County
Evaluation of Existing Pavement Structure

Deflection Analysis

Deflection measurements were made with the Dynaflect Trailer No. 29 along the existing FM 1604 between SH 16 and Babcock Road in February, 1980. Measurements were made 4 feet right of the Center stripe in the inside wheel path of both the North and South Bound Lanes. Attached are the project data, calculated deflections and stiffness coefficients, and a deflection analysis of the pavement structure. The existing pavement structure is shown below. The subgrade consists of stony clay soils over generally limestone bedrock.

1"	Hot Mix Asphaltic Concrete Pavement
8"	Cr. Limestone Flexible Base
9"	Total Thickness

Figure 1 displays graphically the deflection analysis of this section. Pertinent information recorded on Figure 1 is the maximum deflection at W_1, the Surface Curviture Index, SCI, which indicates the load carrying capability of the upper portion of the structure; W_4 less W_5 which indicates the strength of the lower portion of the structure.

An examination of the shape of the deflection basin and the above data show that the maximum deflection is small, less than 1.0 mils. The SCI indicates that the surface is adequately transferring traffic loads to the pavement structure. The numerical difference between W_4 and W_5 is very small indicating good strength in the lower levels of the structure. The stiffness coefficient of the pavement and base, AP_2, is equivalent to the value assigned to high quality crushed stone flexible base material. The stiffness coefficient of the subgrade, AS_2, supports the rocky, stony type of soil. In summary, the deflection analysis indicates the pavement and subgrade sections are strong and adequate to support the present traffic loads.

TEXAS HIGHWAY DEPARTMENT

DISTRICT 15 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 07-10-80

****

PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		FM1604	02-06-80	29

REASONS FOR MEASUREMENTS AND COMMENTS
EX - SULFLEX TEST SECTION

TOTAL PAV DEPTH
9.00 INCHES

****

EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
ASPH.CONC.PVMT.	1.00
FLEX.BASE-RDWY.CUT	8.00
SUBGR.SOILS	0.0

****

GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS SOUTH OPPOSITE MILEPOINTS
MEASUREMENTS ARE 04 FEET FROM THE RIGHT SIDE OF LANE A

DESCRIPTION OF LOCATION	ODOMETER READING	MILEPOINT
FROM-JCT.WHITE FAWN ROAD		
TO- JCT.SH16		

****

PLOTS WERE REQUESTED WITH THIS PROGRAM.

****

SOUTH BOUND LANE

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		FM1604	02-06-80	29

DYNAFLECT DATA

ODOMETER	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
0,00	0,520	0,320	0,081	0,034	0,022	0,200	0,33	0,59	150FT,S,WHITE
0,20	0,540	0,230	0,030	0,025	0,021	0,310	0,40	0,41	UP GRADE
0,40	0,440	0,200	0,043	0,030	0,022	0,240	0,40	0,44	
0,60	0,930	0,870	0,780	0,600	0,023	0,060	0,19	1,84	FILL-ON CULVE
0,80	0,250	0,093	0,040	0,029	0,022	0,157	0,50	0,46	
1,00	0,990	0,750	0,600	0,093	0,060	0,240	0,25	0,83	PATCHED PVMT
1,20	0,780	0,350	0,135	0,060	0,040	0,430	0,36	0,39	SHOULDER CRA
1,40	0,900	0,720	0,600	0,035	0,027	0,180	0,24	0,96	300' N HAUSM
1,60	0,260	0,090	0,040	0,035	0,027	0,170	0,52	0,44	
1,80	0,620	0,350	0,220	0,050	0,032	0,270	0,34	0,51	DOWN GRADE
2,00	0,900	0,720	0,600	0,030	0,025	0,180	0,24	0,96	PATCHED PVMT
2,20	1,440	1,020	0,780	0,660	0,147	0,420	0,24	0,71	
2,40	0,930	0,690	0,340	0,220	0,111	0,240	0,26	0,79	SLIGHT FILL
2,60	0,930	0,720	0,400	0,300	0,250	0,210	0,25	0,88	
2,70	0,960	0,600	0,220	0,135	0,102	0,360	0,29	0,57	RAMP TO SH 16
AVERAGES	0,759	0,515	0,327	0,156	0,062	0,244	0,32	0,72	
STANDARD DEVIATION						0,101	0,10	0,37	

NUMBER OF POINTS IN AVERAGE = 15

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 15 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 07-10-80

****

PROJECT IDENTIFICATION

DIST,	COUNTY	CONT,	SECT,	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		FM1604	02-06-80	29

REASONS FOR MEASUREMENTS AND COMMENTS
EX - SULFLEX TEST SECTION

TOTAL PAV DEPTH
9.00 INCHES

****

EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK,(IN)
ASPH,CONC,PVMT,	1.00
FLEX,BASE-RDWY,CUT	8.00
SUBGR,SOILS	0.0

****

GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NORTH WITH MILEPOINTS
MEASUREMENTS ARE 04 FEET FROM THE RIGHT SIDE OF LANE A

DESCRIPTION OF LOCATION ODOMETER READING MILEPOINT
FROM-JCT, SH16
TO- JCT, WHITE FAWN RD,

****

PLOTS WERE REQUESTED WITH THIS PROGRAM,

****

Norma Rowland

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		FM1604	02-06-80	29

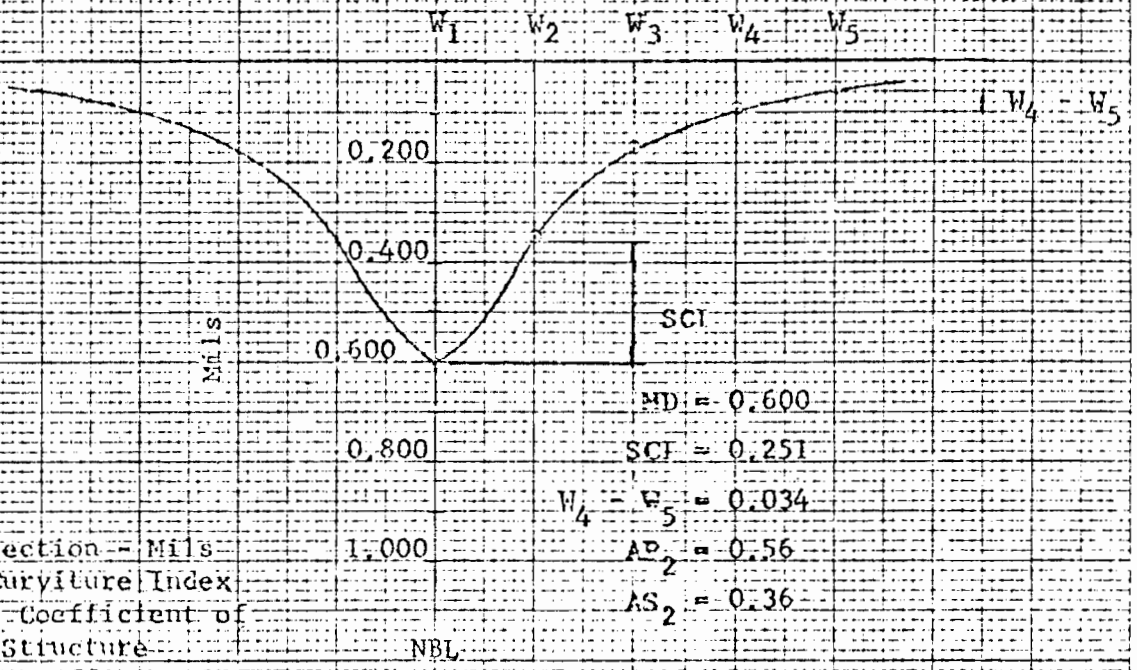
DYNAFLECT DATA

ODOMETER	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
0,00	0,500	0,310	0,210	0,126	0,093	0,190	0,33	0,59	STRUCTURE SH
0,20	0,900	0,600	0,290	0,200	0,099	0,300	0,28	0,64	FILL
0,40	0,570	0,400	0,250	0,129	0,084	0,170	0,30	0,72	
0,60	0,740	0,420	0,330	0,111	0,069	0,320	0,32	0,51	
0,80	0,530	0,300	0,111	0,060	0,040	0,230	0,35	0,53	PATCHED PVMT
1,00	0,230	0,084	0,047	0,042	0,040	0,146	0,52	0,47	
1,20	0,930	0,500	0,270	0,141	0,084	0,330	0,29	0,60	INTER.HAUSMA
1,40	0,670	0,420	0,240	0,129	0,066	0,250	0,31	0,59	
1,60	0,720	0,380	0,135	0,069	0,035	0,340	0,34	0,47	SEALED PATCH
1,80	0,690	0,430	0,230	0,099	0,060	0,260	0,31	0,58	NUMEROUS CRA
2,00	0,840	0,330	0,120	0,066	0,047	0,510	0,37	0,36	SEALED PATCH
2,20	0,560	0,270	0,081	0,043	0,032	0,290	0,37	0,44	
2,40	0,440	0,200	0,060	0,042	0,031	0,240	0,40	0,44	
2,60	0,300	0,093	0,040	0,032	0,028	0,207	0,54	0,41	DOWN GRADE
AVERAGES	0,616	0,345	0,172	0,092	0,058	0,270	0,36	0,52	
STANDARD DEVIATION						0,091	0,08	0,10	

NUMBER OF POINTS IN AVERAGE = 14

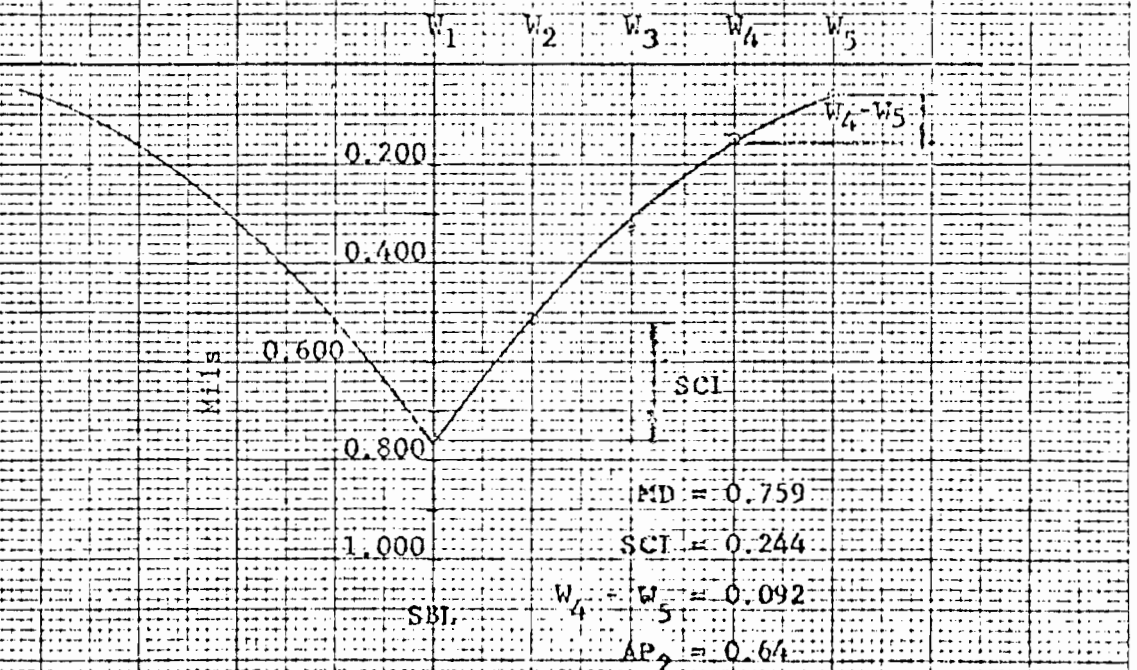
W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

Dynaflect Analysis
Sulphlex Test Section
FM 1604 - Bexar Co.



MD = 0.600
SCI = 0.251
$W_4 - W_5$ = 0.034
AP_2 = 0.56
AS_2 = 0.36

M.D = Max. Deflection - Mils
SCI = Surface Curviture Index
AP_2 = Stiffness Coefficient of Pavement Structure
AS_2 = Stiffness Coefficient of Subgrade Soils



MD = 0.759
SCI = 0.244
$W_4 - W_5$ = 0.092
AP_2 = 0.64
AS_2 = 0.32

Deflection Basins

Average Monthly Temperatures

From U.S. Weather Service Located at S. A. International Airport

	1978	1979	1980
Jan.		43.7	52.6
Feb.		52.4	53.7
Mar.		63.3	61.5
Apr.		69.7	67.6
May	77.1	73.9	76.1
June	82.7	80.9	
Jul.	86.1	84.7	
Aug.	83.1	83.1	
Sept.	78.5	78.7	
Oct.	69.3	74.7	
Nov.	62.4	58.2	
Dec.	51.7	55.4	

Average Traffic Data

3,780 - 5,630 ADT (1979)

A Count of Truck Mix is to be Completed o/a August 20th.

MATERIALS AND TESTS DIVISION
BITUMINOUS SECTION
MIX DESIGN SHEET

ate 8-8-80	District No. 15
pec. Item No. 340	Material Ident. 15-80-1414
ype "D" SHMCP	Design No. 3-A 4.5% AC-20

Sieve Size	15-80-1410 Silica		15-80-1411 L.S.S.		15-80-1412 Lmstn #10		15-80-1413 S/S #4				Comb. Grad.	T.H. Sp
	Sieve Analysis	27.5	Sieve Analysis	7.0	Sieve Analysis	22.5	Sieve Analysis	43.0	Sieve Analysis			
5/8"	0	0	0	0	0	0	0	0			0.0	0.0
3" - 1/2"	0	0	0	0	0	0	.7	.3			0.3	0.3
2" — 3/8"	0	0	0	0	0	0	31.4	13.5			13.5	12.
3" — 3/8"												
1" — No.4	.2	0	0	0	5.9	1.3	61.9	26.6			27.9	26.
1" — No.4												
1" — No.10												
4 — No.10	.4	.1	15.9	1.1	82.3	18.5	3.8	1.6			21.3	20.
et. No.10											63.0	60.
0 — No.40	24.5	6.7	37.3	2.6	8.0	1.8	.5	.2			11.3	10.
0 — No.80	49.5	13.6	12.5	.9	.4	.1	.2	.1			14.7	14.
0 — No.200	19.7	5.4	11.0	.8	.6	.2	.5	.2			6.6	6.3
s No.200	5.7	1.7	23.3	1.6	2.8	.6	1.0	.5			4.4	4.2
Total	100.0	27.5	100.0	7.0	100.0	22.5	100.0	43.0			100.0	95.

Project 30-3-24015-807
FM 1604, Bexar County

Type "D" Control Design Sample No 15-80-1414
Type "D" Sulphlex Design Sample No. 15-80-1415

E. L. Nagel
Inspector

No. D-9-F24

MATERIALS AND TESTS DIVISION
BITUMINOUS SECTION
MIX DESIGN SHEET

Date 8-8-80	District No. 15
Spec. Item No. 340	Material Ident. 15-80-1415
Type "D" SHMCP	Design No. 3-S 8.0% Sulphlex

Sieve Size	15-80-1410 Silica Sieve Analysis	27.5	15-80-1411 L.S.S. Sieve Analysis	7.0	15-80-1412 Lmstn #10 Sieve Analysis	22.5	15-80-1413 S/S #4 Sieve Analysis	43.0	Sieve Analysis		Comb. Grad.	T.H. Spec
5/8"	0	0	0	0	0	0	0	0			0.0	0.0
- 1/2"	0	0	0	0	0	0	.7	.3			0.3	0.
"- 3/8"	0	0	0	0	0	0	31.4	13.5			13.5	12.
"- 3/8"												
"- No.4	.2	0	0	0	5.9	1.3	61.9	26.6			27.9	25.
"- No.4												
"- No.10												
- No.10	.4	.1	15.9	1.1	82.3	18.5	3.8	1.6			21.3	19.
t. No.10											63.0	58.
- No.40	24.5	6.7	37.3	2.6	8.0	1.8	.5	.2			11.3	10.
- No.80	49.5	13.6	12.5	.9	.4	.1	.2	.1			14.7	13.
- No.200	19.7	5.4	11.0	.8	.6	.2	.5	.2			6.6	6.1
s No.200	5.7	1.7	23.3	1.6	2.8	.6	1.0	.5			4.4	4.0
Total	100.0	27.5	100.0	7.0	100.0	22.5	100.0	43.0			100.0	92.

Project 30-3-24015-807
FM 1604, Bexar County

Type "D" Control Design Sample No 15-80-1414
Type "D" Sulphlex Design Sample No. 15-80-1415

E. L. Mod
Inspector

No. D-9-F24

APPENDIX B

SPECIAL PROVISION

TO

ITEM 340

HOT MIX ASPHALTIC CONCRETE PAVEMENT
(CLASS A)

For this project, Item 340, "Hot Mix Asphaltic Concrete Pavement (Class A)", of the Standard Specifications, is hereby amended with respect to the clauses cited below and no other clauses or requirements of this item are waived or changed hereby.

Article 340.2 Materials is supplemented by the following:

(3) Additives. The addition of additives to facilitate mixing and/or improve the quality of the asphaltic mixture may be used upon written permission by the Engineer.

Article 340.2 Materials, Subarticle (1) Mineral Aggregate, Section (a) Coarse Aggregate is supplemented by the following:

For Surface Course Only:

The coarse aggregate shall be that part of the aggregate retained on a No. 10 sieve, shall consist of clean, tough, durable fragments of stone, crushed blast-furnace slag, crushed gravel, gravel, iron-ore topsoil, oyster shell, cinder aggregate (produced from burning lignite or coal),crushed limestone rock-asphalt, synthetic aggregate (herein defined as aggregate produced by fusing raw shale or clay in a rotary kiln under intense heat into predominately amorphous silicate), or combination thereof as herein after specified and/or as shown on plans, of uniform quality throughout. When specified on the plans, other coarse-aggregate material may be permitted or required.

That portion of the coarse aggregate composed of synthetic aggregate shall meet the following requirements: The dry loose unit weight shall be at least 35 pounds per cubic foot and shall not exceed 60 pounds per cubic foot when tested in accordance with Test Method Tex-404-A. However, synthetic materials from one source, with same or similar gradation, whose unit weights vary by more than $\pm$ 6 percent from that submitted for the acceptance test and used in the batch design may not be mixed together in the same batch. The "Pressure Slaking Value" shall not exceed 6 percent when tested in accordance with Test Method Tex-431-A, Tentative. The "Aggregate Freeze-thaw Loss" shall not exceed 15 percent when tested in accordance with Test Method Tex-432-A, Tentative.

When shown on the plans, the coarse aggregate used in the surface or finish course on the travel lanes or elsewhere when shown on the plans must meet one of the following conditions:

1. Have a "polish value" of not less than the value shown on the plans. Where the coarse aggregates are supplied from two or more sources, the aggregate from each source shall meet the "polish value" shown on the plans prior to being combined with other aggregates. Polish values shall be determined in accordance with Test Method Tex-438-A, Part I.

2. Have a "combined polish value" achieved by blending non-polishing aggregates with polishing aggregates in specific proportions as determined by Method "A" or Method "B" of Test Method Tex-438-A, Part II.

The non-polishing aggregate shall be so sized that it will constitute at least 50% by volume of the aggregate retained on the 3/8" sieve for a Type "C" mixture; at least 50% by volume of the aggregate retained on the No. 4 sieve for a Type "D" mixture; and at least 50% by volume of the aggregate retained on the No. 10 for a Type "F" mixture. The amount of non-polishing aggregate required may be determined by either Method "A" or Method "B" of Test Method Tex-438-A, Part II. When Method "A" is used the percent by volume of the non-polishing aggregate in the total coarse aggregate of the blend shall be that amount required to provide the polish value shown on the plans, plus 2. When Method "B" is used the percent by volume of the non-polishing aggregate in the total coarse aggregate of the blend is determined by the formula base on the polish values of the aggregates to be blended and in addition, the non-polishing aggregate must be equal to or greater in differential wear resistance than the coarse aggregate to be improved by blending when tested in accordance with Test Method Tex-438-A, Part III. The formula used in Method "B" is shown on the attached chart.

When coarse aggregates from any source include appreciable quantities of materials with substantially different mineralogy the more polish-resistant aggregates must be equal or greater in differential wear resistance than other aggregates from the source. The Engineer may establish this on the basis of satisfactory experience with the source or tests may be required in accordance with Test Method Tex-438-A, Part III.

Specification compliance for proper proportioning of blended coarse aggregate shall be determined from representative samples obtained from the hot bins on conventional plants or from the cold feed immediately prior to entering the dryer-drum on the dryer-drum plants. Percent by volume may be determined by making a visual separation of the materials as outlined in Test Method Tex-413-A and converting weights to volumes by appropriate methods or by testing in accordance with Test Method Tex-200-F, Part III.

For Dryer Drum Only:

The aggregate sample shall be taken from the stockpile and the material removed and tested in accordance with Test Method Tex-217-F, Part II, Decantation shall not exceed one percent.

Article 340.3 Paving Mixture, Subarticle (1) Types, is supplemented by the following:

When used for the lower mat of the surface course on the travel lanes, or elsewhere when shown on the plans, the total materials retained between the 40-80 and the 80-200 sieves shall be not less than 20% of the paving mixture.

Article 340.3 Paving Mixture, Subarticle (1) Types, Type "C" (Coarse Graded Surface Course). The last sentence is voided and replaced by the following:

The asphalt material shall form from 3.5 to 12.0 percent of the mixture by weight unless specified otherwise on the plans.

Article 340.3. Paving Mixture, Subarticle (1) Types, Type "D" (Fine Graded Surface Course) is voided and replaced by the following:

Type "D" (Fine Graded Surface Course):

Passing 5/8" sieve	100
Passing 1/2" sieve	95 - 100
Passing 3/8" sieve	85 - 100
Passing 3/8" sieve, retained on No. 4 sieve	20 - 50
Passing No. 4 sieve, retained on No. 10 sieve	10 - 30
Total retained on No. 10 sieve	50 - 75
Passing No. 10 sieve, retained on No. 40 sieve	0 - 30
Passing No. 40 sieve, retained on No. 80 sieve	4 - 25
Passing No. 80 sieve, retained on No. 200 sieve	3 - 25
Passing No. 200 sieve	0 - 6

The asphaltic material shall form from 4.0 to 12.0 percent of the mixture by weight unless specified otherwise on the plans.

Article 340.3. Paving Mixtures, Subarticle (4) Sampling and Testing is supplemented by the following:

For Surface Course Only:

It is the intent of this specification to produce a mixture which when designed and tested in accordance with these specifications and methods outlined in THD Bulletin C-14 will have the following laboratory density and stability unless otherwise shown on the plans.

Density, Percent			Stability, Percent
Min	Max	Optimum	Not less than 30 unless
93	99	96	otherwise shown on plans

Stability and density are control tests. If the laboratory stability and/or density of the mixture produced has a value lower than that specified and in the opinion of the Engineer is not due to change in source or quality of materials, production may proceed, and the mix shall be changed until laboratory stability and density falls within the specified limits and as near the optimum value as is practicable. If there is, in the opinion of the Engineer, a fundamental

change in any material from that used in the design mixtures, production will be discontinued until a new design mixture is determined by trial mixes. It is the intent of this specification that the mixture will be designed to produce a mixture of optimum density.

Article 340.4 Equipment, Subarticle (1) Mixing Plants is supplemented by the following:

(c) Dryer-Drum Mixing Plant. The Contractor may, at his option, elect to use the dryer-drum mixing process in the mixing of asphaltic concrete material. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt in the dryer-drum without preheating the aggregates. The plant shall be equipped with satisfactory conveyors, power units, aggregate-handling equipment and feed controls and shall consist of the following essential pieces of equipment.

Cold Aggregate Bin and Feed System. The number of compartments in the cold aggregate bin shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bin shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material of one bin to that of another bin. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. Each aggregate shall be proportioned in a separate compartment with total and proportional control.

The system shall provide positive weight measurement of the combined cold aggregate feed by use of belt scales or other devices. A scalping screen will be required, unless otherwise shown on the plans.

Asphaltic Material Measuring System. An accurate asphaltic material measuring device shall be placed in the asphalt line leading to the dryer-drum mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The asphalt measuring device and line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line and measuring device near that temperature specified for the asphaltic material. Unless otherwise shown on the plans the temperature of the asphaltic material entering the measuring device shall be maintained at $\pm$ 10 F of the temperature at which the asphalt measuring device was calibrated and set.

If a pressure type flow meter is used to measure the asphaltic material, the requirements of the Item "Weighing and Measuring Equipment" shall apply.

Synchronization Equipment for Feed Control Systems. The asphaltic material feed control shall be coupled with the total aggregate weight measurement device in such manner as to automatically vary the asphalt feed rate as required to maintain the required proportion.

Dryer-Drum Mixing System. The dryer-drum system shall be of the type that continually agitates the aggregate and asphalt mixture during heating and in which the temperature can be so controlled that aggregate and asphalt will not be injured in the necessary drying and heating operations required to obtain a mixture of the specified temperature. A continuous recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the dryer-drum mixer. The dryer-drum mixing system shall be of sufficient size to keep the plant in continuous operations.

Surge-Storage System. A surge-storage system will be required and it shall be adequate to minimize the production interruptions during the normal day's operations.

Truck Scales. A set of standard platform truck scales, conforming to the Item "Weighing and Measuring Equipment", shall be placed at a location approved by the Engineer.

(d) Modified Weight-batching Type. The Contractor may elect to operate the weight-batching type of hot-mix plant without the hot bin requirements where cold feed control of aggregates will determine the final mix. All equipment shall be the same as that required for weight-batching type plants as described under Article 340.4 Equipment, Subarticle (1) Mixing Plants article (a) Weight-batching Type, except as modified below.

Cold Aggregate Bin and Proportioning Device. Same requirements as the Weight-Batching Type and the following additional requirements:

Each aggregate shall be proportioned by separate positive feeders that can be accurately calibrated. The feed shall be quick adjusting and shall maintain a constant and uniform flow throughout the range of its calibration.

When directed by the Engineer a scalping screen and vibrator will be required on the cold aggregate bin.

Screening and Proportioning. Requirements of the weight-batching type are voided and replaced by the following:

The hot bins shall be provided with a scalping screen capable of eliminating oversized material. A surge bin or hot bin shall be provided between the dryer and the weight hopper. The discharge into the weight hopper shall be from one bin only which shall discharge directly into and in close proximity to the center of the weight hopper.

Operations shall discontinue upon failure to maintain production within the specified limits of the design mixture.

The size of the hot bin or surge bin shall be sufficient to store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. Provisions shall be made to enable inspection forces to have easy and safe access to the proper locations on the mixing plant where representative samples may be taken from the hot bin or surge bin for testing.

The amount of aggregate stored in the hot bin or surge bin shall be of sufficient quantity to keep the plant in continuous operation and shall be fed into the hot bin or surge bin in a manner that will prevent sluffing and segregation.

Article 340.5. Stockpiling, Storage, Proportioning and Mixing, Subarticle (1) Stockpiling of Aggregates is voided and replaced by the following:

(1) Stockpiling and Aggregates. Prior to stockpiling of aggregates, the area shall be cleaned of trash, weeds and grass and be relatively smooth. Aggregates shall be stockpiled in such a manner as to prevent mixing of one aggregate with another. Coarse aggregates for "B", "C" and "D" shall be separated into at least two stockpiles of different gradation, such as a large coarse aggregate and a small coarse aggregate stockpile and such that the grading requirements of the specified type will be met when the piles are combined in the asphaltic mixture. In the event that the Contractor elects to use a blended mix, additional stockpiles will be required as necessary for coarse aggregates "B", "C" and "D". For weight batching type plants, no coarse aggregate stockpile shall contain more than 15 percent by weight of material that will pass a No. 10 sieve except as noted on the plans. Fine aggregate stockpiles may contain coarse aggregate in the amount of up to 20 percent by weight; however, the coarse aggregate shall meet the quality tests specified herein for "Coarse Aggregates". For dryer-drum type plants and modified weight-batching type plants, no coarse aggregate stockpile shall contain more than 10% by weight of material that will pass a No. 10 sieve except as noted on the plans. Fine aggregate stockpiles may contain coarse aggregate in the amount of up to 20% by weight, however, the coarse aggregate shall meet the quality tests specified herein for "Coarse Aggregates". Additionally for dryer-drum and modified weight-batching type plants, once a coarse aggregate stockpile has begun to be used in a mix, no additional material shall be placed on that stockpile and a minimum of four days supply of material must be in the stockpiles before the plant begins to furnish mix to a project, unless authorized in writing by the Engineer. Suitable equipment of acceptable size shall be furnished by the Contractor to work the stockpiles and prevent segregation of the aggregates.

Article 340.5. Stockpiling, Storage, Proportioning and Mixing.

When a dryer-drum mixing plant is used, the following requirements will apply:

(2) Storage and Heating of Asphaltic Materials. Same as for other types of plants.

(3) & (4) Proportioning and Feeding Materials. The proportioning of the various materials entering the asphaltic mixture shall be as directed by the Engineer and in accordance with these specifications. The feedings of various sizes of aggregate to the dryer-drum mixer shall be done through the cold aggregate bin and feed system in such a manner that a uniform and constant flow of materials in the required proportions will be maintained. The asphaltic material shall be introduced into the dryer-drum mixer through the asphaltic measuring device. It will be the responsibility of the Contractor to demonstrate, prior to production, that the aggregates are being blended in the proper proportions to satisfy the specifications before entering the dryer-drum mixer.

(5) Mixing and Storage.

(a) The amount of aggregate and asphaltic material entering the dryer-drum mixer and the rate of travel through the mixing unit shall be so coordinated that a uniform mixture of the specified grading and asphaltic content will be produced.

(b) Temporary storing or holding of the asphaltic mixture by the surge-storage system may be used during the normal day's operation. Overnight storage will not be permitted unless authorized in the plans or in writing by the Engineer. The mixture coming out of the surge-storage bin must be of equal quality to that coming out of the dryer-drum mixer. The mixture when discharged from the plant shall have a moisture content not greater than 3% by weight unless otherwise shown on the plans and/or specified by the Engineer. The moisture content shall be determined in accordance with Test Method Tex-212-F, Part II.

(c) The asphaltic mixture shall be at a temperature between 175 F and 300 F . when discharged from the plant. The Engineer will determine the temperature within the above limitations, and the mixture when discharged from the plant shall not vary from this selected temperature more than 25 F.

Article 340.7. Measurement is supplemented by the following:

When dryer-drum process is used, measurement will be made on truck scales, except as noted below.

For Surface Courses and Other Courses when cubic yard measurement is specified on plans.

Asphaltic concrete will be measured separately by the ton of 2,000 pounds of "Asphalt" and by the cubic yard of laboratory-compacted "Aggregate" of the type actually used in the completed and accepted work in accordance with plans and specifications for the project. The volume of aggregate in the compacted mix shall be calculated from the measured weights of asphaltic concrete by the following formula:

$$V = \frac{W}{62.4\ (27)\ GA}$$

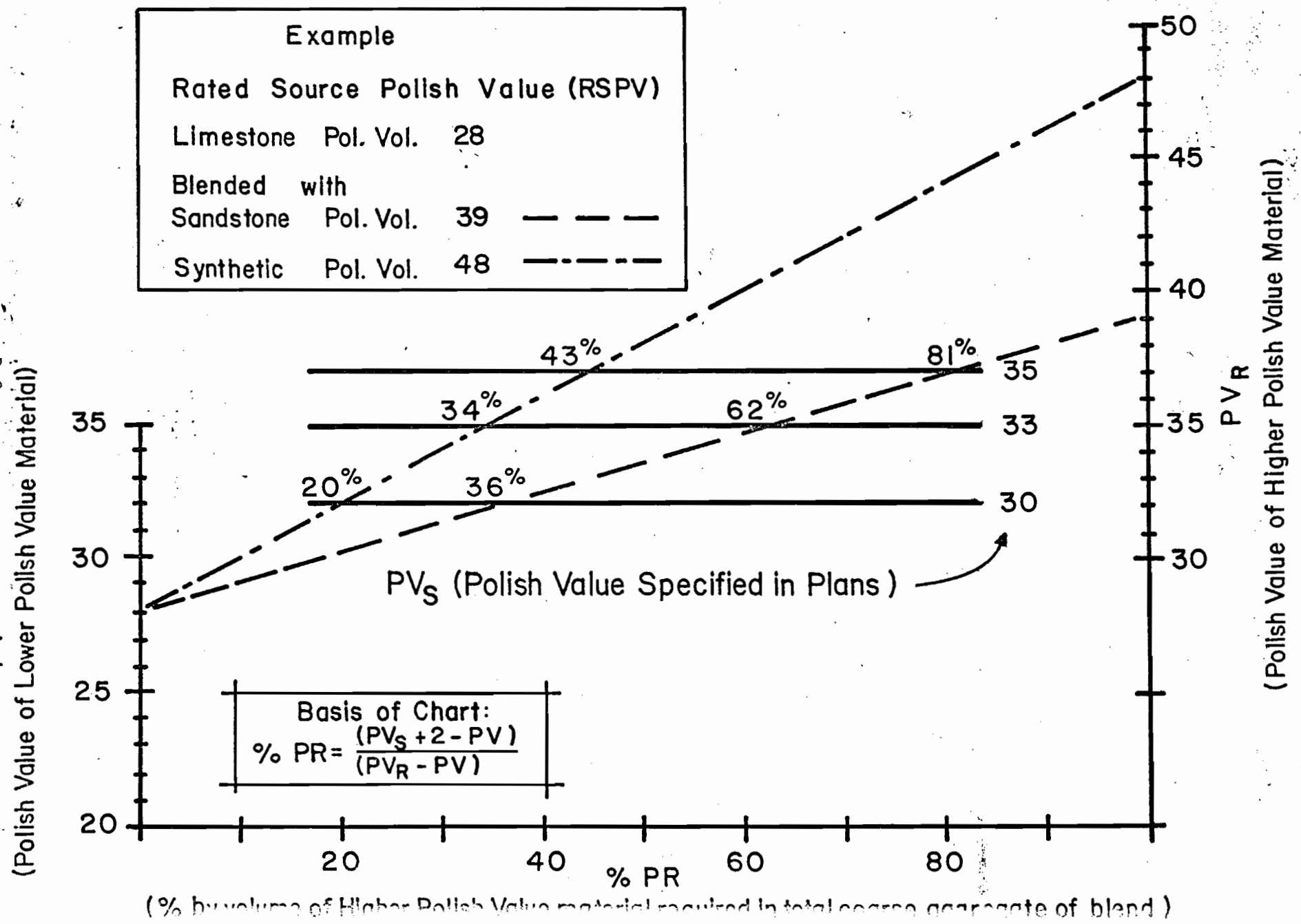
V = Cubic yards of compacted aggregate
W = Total weight of asphaltic-concrete mixture in pounds
Ga = Average actual specific gravity of three molded specimens as prepared by Test Method Tex-206-F and determined in accordance with Test Method Tex-207-F

The weight "W" if mixing is done by a continuous mixer will be determined by turck scales adjusted as specified in Section 340.4(1)(b). Weight, if mixing is done by a batch mixer or modified weight-batch mixer, will be determined by batch scales and records of the number of batches, batch designs and weight of asphalt

and aggregate shall be kept. Where surge-storage is used, measurement of material taken from the surge-storage bin will be made on truck scales. When the dryer-drum process is used the weight "W" will be determined by truck scales.

For the first day's production, the average actual specific gravity of specimens molded during laboratory design of the mix shall be used in the volume-computation formula. For each subsequent day's production the average actual specific gravity of specimens molded from the previous day's production shall be used.

DETERMINATIONS OF PERCENTAGES FOR BLENDS



B-9

340---102

APPENDIX C

Marshall Stability and Flow Data are not available at this time. They will be included in the final version of the Design and Construction Report.

APPENDIX D

STATE DEPARTMENT OF
HIGHWAYS AND PUBLIC TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
AUSTIN, TEXAS 78703

Design (Supplier) Lab Specimens PAGE 233

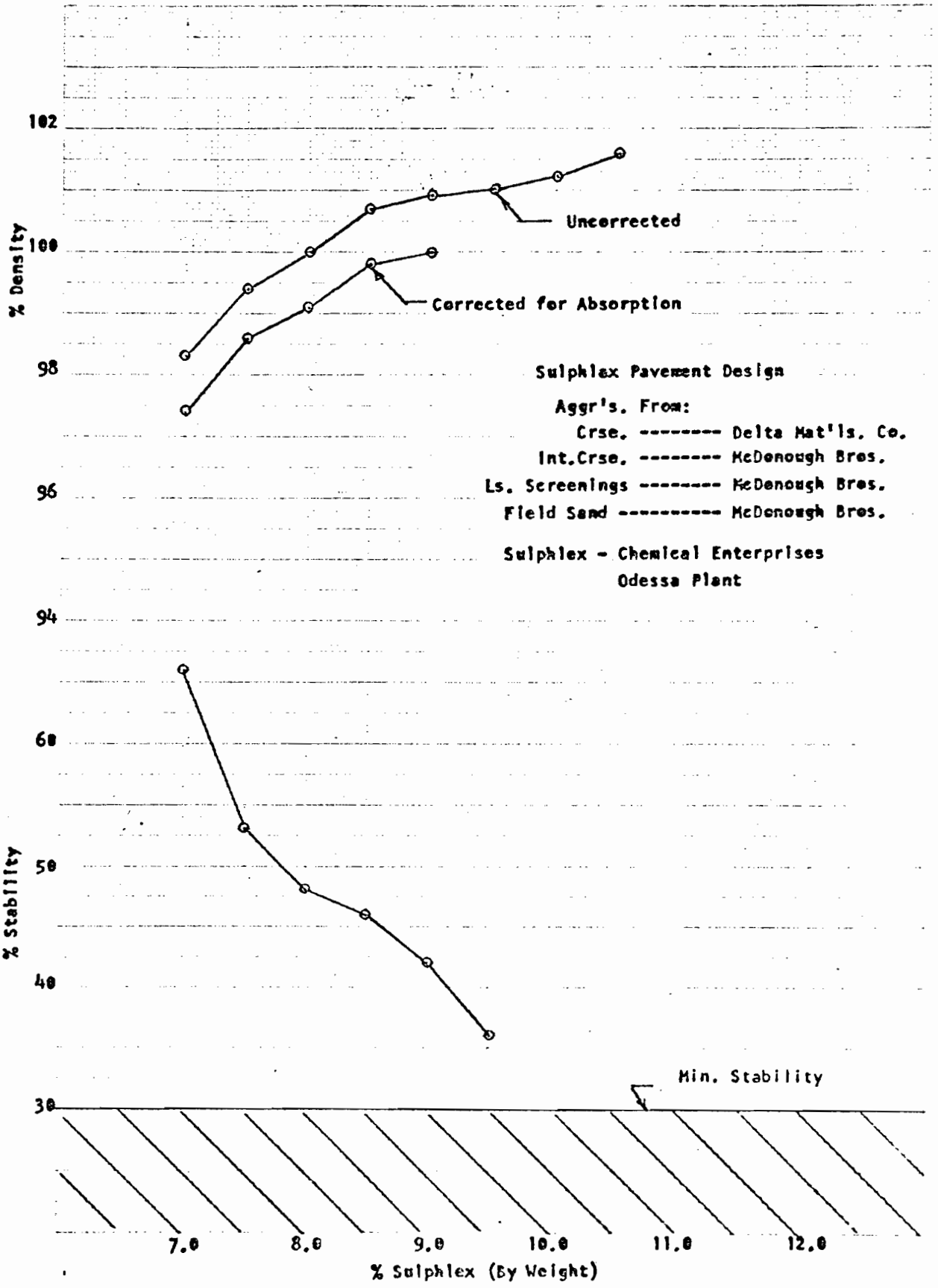
MCS.TST.14 ASPHALTIC CONCRETE STABILITY REPORT D-9 CHARGES 67.50

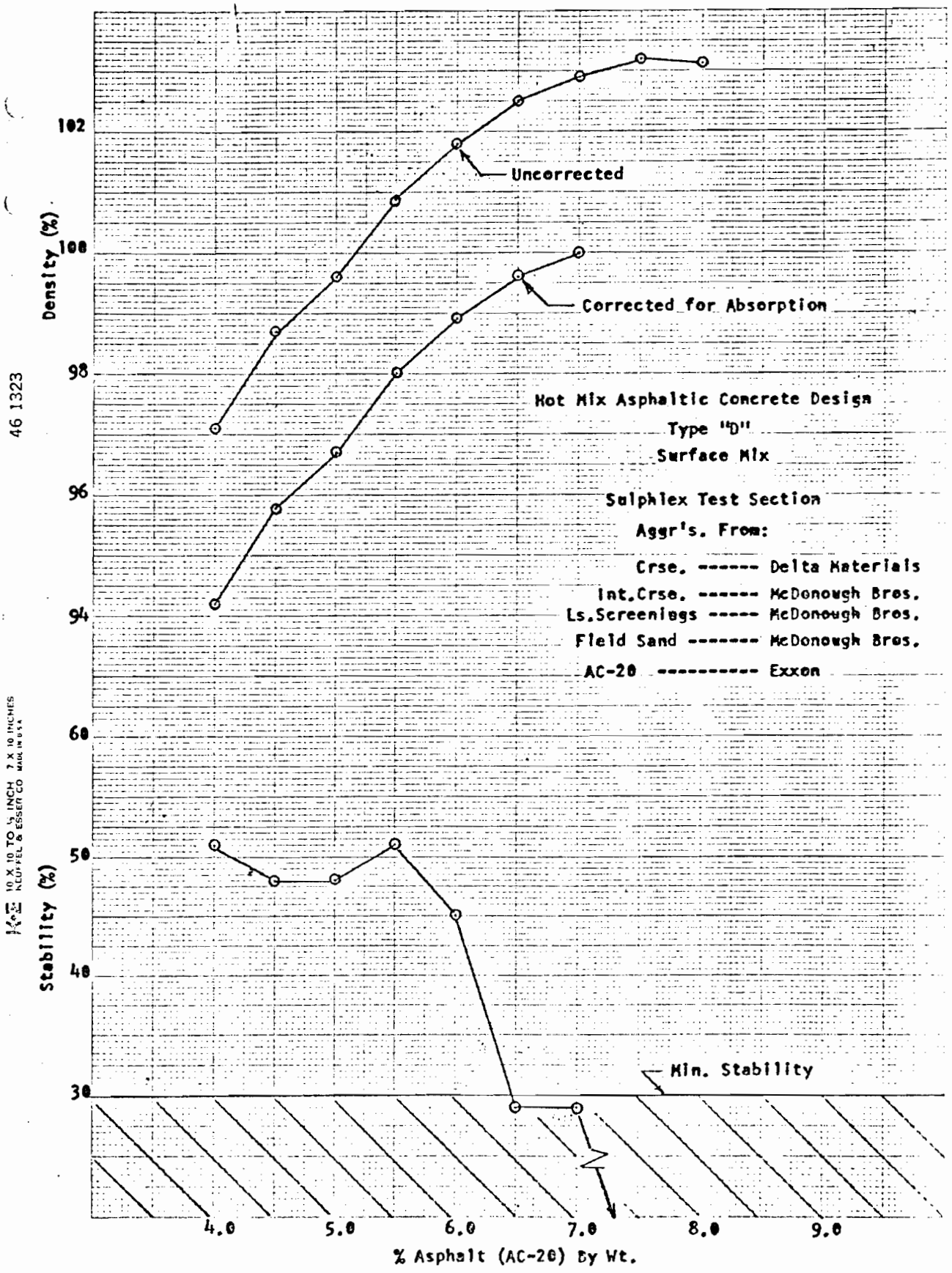
CONTRACT NO. REQ NO. CONTROL - - 0000
ENGINEER R. H. MAGERS PROJECT 30-3-0240-054415-807
CONTRACTOR DIST 49 CO HWY

LABORATORY NO. H80404914 DATE RECD 08/19/80 DATE REPTD 08/20/80
DATE SAMPLED 08/15/80
MATERIAL CODE 0000000000
PRODUCER CODE 000
IDENTIFICATION MARKS SPEC. ITEM 0340
SAMPLED FROM DESIGN S-3 QUANTITY UNIT

SAMPLE NUMBER	SPEC. NO.	IDENT. MARKS	COHESIOMETER VALUE (AVG.)	ASPHALT (% BY WT.)	SPEC. HT. (IN.)	SPEC.DENS. FIELD (AVG. %)	HVEEM STABILITY (%)	(AVG.%)
52	1	15-80-1415			2.06		72	
	2			7.0	2.06		64	66
	3				2.05		62	
53	1	15-80-1415			2.05		51	
	2			7.5	2.04		52	53
	3				2.04		56	
54	1	15-80-1415			2.02		45	
	2			8.0	2.03		48	48
	3				2.02		50	
55	1	15-80-1415			2.00		40	
	2			8.5	2.02		48	45
	3				2.01		48	
56	1	15-80-1415			2.01		44	
	2			9.0	2.02		35	41
	3				2.01		45	
57	1	15-80-1415			2.04		33	
	2			9.5	2.03		38	36
	3				2.03		36	

****
* HVEEM STABILITY *
* AND/OR COHESIOMETER *
* VALUES *
* MEET SPECIFICATION *
****


102
100
98
96
94
% Density
Uncorrected
Corrected for Absorption
Sulphlex Pavement Design
Aggr's. From:
Crse. -------- Delta Mat'ls. Co.
Int.Crse. -------- McDonough Bros.
Ls. Screenings -------- McDonough Bros.
Field Sand ---------- McDonough Bros.
Sulphlex - Chemical Enterprises
Odessa Plant
60
50
40
% Stability
Min. Stability
30
7.0
8.0
9.0
10.0
11.0
12.0
% Sulphlex (By Weight)


Density (%)
102
100
98
96
94
Uncorrected
Corrected for Absorption
Hot Mix Asphaltic Concrete Design
Type "D"
Surface Mix
Sulphlex Test Section
Aggr's. From:
Crse. ------ Delta Materials
Int.Crse. ------ McDonough Bros.
Ls.Screenings ----- McDonough Bros.
Field Sand ------- McDonough Bros.
AC-20 ---------- Exxon
60
50
40
30
Stability (%)
Min. Stability
4.0
5.0
6.0
7.0
8.0
9.0
% Asphalt (AC-20) By Wt.
46 1323
10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO MADE IN U.S.A.

MATERIALS AND TESTS DIVISION
BITUMINOUS SECTION
MIX DESIGN SHEET

Date 8-8-80	District No. 15
Spec. Item No. 340	Material Ident.
Type "D" SHMCP	Design No. 3-S 7.0% Sulphlex

15-80-1410 15-80-1411 15-80-1412 15-80-1413

Sieve Size	Silica		L.S.S.		Lmst. #10		SS #4				Comb. Grad.	T.H.D Spec.
	Sieve Analysis	27.5	Sieve Analysis	7.0	Sieve Analysis	22.5	Sieve Analysis	43.0	Sieve Analysis			
5/8"	0	0	0	0	0	0	0	0			0.0	
5/8"-1/2"	0	0	0	0	0	0	.7	.3			0.3	.3
5/8"—3/8"	0	0	0	0	0	0	31.4	13.5			13.5	12.6
3/8"—No.4												
1/4"—No.4	.2	0	0	0	5.9	1.3	61.9	26.6			27.9	25.9
1/4"—No.10												
No.4—No.10	.4	.1	15.9	1.1	82.3	18.5	3.8	1.6			21.3	19.8
Ret. No.10											63.0	58.8
No.10—No.40	24.5	6.7	37.3	2.6	8.0	1.8	.5	.2			11.3	10.5
No.40—No.80	49.5	13.6	12.5	.9	.4	.1	.2	.1			14.7	13.7
No.80—No.200	19.7	5.4	11.0	.8	.6	.2	.5	.2			6.6	6.1
Pass No.200	5.7	1.7	23.3	1.6	2.8	.6	1.0	.5			4.4	4.1
Total	100.00	27.5	100.0	7.0	100.0	22.5	100.0	43.0			100.0	93.0

Project 30-3-24015-807
FM 1604, Bexar County
Type "D" Control Design Sample No. 15-80-1414
Type "D" Sulphlex Design Sample No. 15-80-1415

Inspector

Form No. D-9-F24

MATERIALS AND TESTS DIVISION
BITUMINOUS SECTION
MIX DESIGN SHEET

Date 8-8-80	District No. 15
Spec. Item No. 340	Material Ident.
Type "D" SHMCP	Design No. 3-S 7.5% Sulphlex

Sieve Size	15-80-1410 Silicia		15-80-1411 L.S.S.		15-80-1412 Lmst. #10		15-80-1413 SS #4				Comb. Grad.	T.H. Spe
	Sieve Analysis	27.5	Sieve Analysis	7.0	Sieve Analysis	22.5	Sieve Analysis	43.0	Sieve Analysis			
5/8"	0	0	0	0	0	0	0	0			0.0	
5/8"-1/2"	0	0	0	0	0	0	.7	.3			0.3	
5/8"–3/8"	0	0	0	0	0	0	31.4	13.5			13.5	12.
3/8"–No.4												
1/4"–No.4	.2	0	0	0	5.9	1.3	61.9	26.6			27.9	25.
1/4"–No.10												
No.4–No.10	.4	.1	15.9	1.1	82.3	18.5	3.8	1.6			21.3	19.
Ret. No.10											63.0	59.
No.10–No.40	24.5	6.7	37.3	2.6	8.0	1.8	.5	.2			11.3	10.
No.40–No.80	49.5	13.6	12.5	.9	.4	.1	.2	.1			14.7	13.
No.80–No.200	19.7	5.4	11.0	.8	.6	.2	.5	.2			6.6	6.
Pass No.200	5.7	1.7	23.3	1.6	2.8	.6	1.0	.5			4.4	4.
Total	100.0	27.5	100.0	7.0	100.0	22.5	100.0	43.0			100.0	92.

Project 30-3-24015-807
FM 1604, Bexar County
Type "D" Control Design Sample No. 15-80-1414
Type "D" Sulphlex Design Sample No. 15-80-1415

Inspector

Form No. D-9-F24

MATERIALS AND TESTS DIVISION
BITUMINOUS SECTION
MIX DESIGN SHEET

Date 8-8-80	District No. 15
Spec. Item No. 340	Material Ident.
Type "D" SHMCP	Design No. 3-S 8.0% Sulphlex

15-80-1410 15-80-1411 15-80-1412 15-80-1413

Sieve Size	Silica		L.S.S.		Lmst. #10		SS #4				Comb. Grad.	T.H. Spe
	Sieve Analysis	27.5	Sieve Analysis	7.0	Sieve Analysis	22.5	Sieve Analysis	43.0	Sieve Analysis			
5/8"	0	0	0	0	0	0	0	0			0.0	
5/8"-1/2"	0	0	0	0	0	0	.7	.3			0.3	.
5/8"—3/8"	0	0	0	0	0	0	31.4	13.5			13.5	12.
3/8"—No.4												
1/4"—No.4	.2	0	0	0	5.9	1.3	61.9	26.6			27.9	25.
1/4"—No.10												
No.4—No.10	.4	.1	15.9	1.1	82.3	18.5	3.8	1.6			21.3	19.
Ret. No.10											63.0	58.
No.10-No.40	24.5	6.7	37.3	2.6	8.0	1.8	.5	.2			11.3	10.
No.40-No.80	49.5	13.6	12.5	.9	.4	.1	.2	.1			14.7	13.
No.80-No.200	19.7	5.4	11.0	.8	.6	.2	.5	.2			6.6	6.
Pass No.200	5.7	1.7	23.3	1.6	2.8	.6	1.0	.5			4.4	4.
Total	100.0	27.5	100.0	7.0	100.0	22.5	100.0	43.0			100.0	92.

Project 30-3-24015-807
FM 1604, Bexar County
Type "D" Control Design Sample No. 15-80-1414
Type "D" Sulphlex Design Sample No. 15-80-1415

Inspector

Form No. D-9-F24

MATERIALS AND TESTS DIVISION
BITUMINOUS SECTION
MIX DESIGN SHEET

Date 8-8-80	District No. 15
Spec. Item No. 340	Material Ident.
Type "D" HMAC	Design No. 4.7% AC 20

15-80-1410 15-80-1411 15-80-1412 15-80-1413

Sieve Size	Silica		L.S.S.		Lmst. #10		SS #4				Comb. Grad.	T.H.D. Specs
	Sieve Analysis	27.5	Sieve Analysis	7.0	Sieve Analysis	22.5	Sieve Analysis	43.0	Sieve Analysis			
5/8"	0	0	0	0	0	0	0	0			0.0	
5/8"-1/2"	0	0	0	0	0	0	.7	.3			0.3	.3
5/8"-3/8"	0	0	0	0	0	0	31.4	13.5			13.5	12.9
3/8"-No.4												
1/4"-No.4	.2	0	0	0	5.9	1.3	61.9	26.6			27.9	26.9
1/4"-No.10												
No.4-No.10	.4	.1	15.9	1.1	82.3	18.5	3.8	1.6			21.3	20.
Ret. No.10											63.0	60.
No.10-No.40	24.5	6.7	37.3	2.6	8.0	1.8	.5	.2			11.3	10.
No.40-No.80	49.5	13.6	12.5	.9	.4	.1	.2	.1			14.7	14.
No.80-No.200	19.7	5.4	11.0	.8	.6	.2	.5	.2			6.6	6.
Pass No.200	5.7	1.7	23.3	1.6	2.8	.6	1.0	.5			4.4	4.
Total	100.0	27.5	100.0	7.0	100.0	22.5	100.0	43.0			100.0	95.3

Project 30-3-24015-807
FM 1604, Bexar County
Type "D" Control Design Sample No. 15-80-1414
Type "D" Sulphlex Design Sample No. 15-80-1415

Inspector

Form No. D-9-F24

APPENDIX E

M A T E R I A L S A F E T Y D A T A S H E E T PAGE: 1

DOW CHEMICAL U.S.A. MIDLAND MICHIGAN 48640 EMERGENCY PHONE: 517-636-4400

EFFECTIVE DATE: 08 JUN 77 DATE PRINTED: 18 JUL 77 PRODUCT CODE: 91606

PRODUCT NAME: VINYL TOLUENE (12T AND 50T INHIBITOR GRADES) MSD: 0201

INGREDIENTS (TYPICAL VALUES-NOT SPECIFICATIONS)	%
VINYLTOLUENE, MINIMUM	99.2

SECTION 1 PHYSICAL DATA

BOILING POINT: 333.9F : SOL. IN WATER: 0.0089%
VAP PRESS: 1.10 MMHG @ 20C : SP. GRAVITY: 0.9164 @ 60/60F
VAP DENSITY (AIR=1): 4.08 : % VOLATILE BY VOL: NOT APPL.
APPEARANCE AND ODOR: CLEAR LIQUID, DISAGREEABLE ODOR.

SECTION 2 FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: 127F : FLAMMABLE LIMITS (STP IN AIR)
METHOD USED: TAG CLOSED CUP : LFL: 0.8 UFL: 11
EXTINGUISHING MEDIA: WATER FOG, FOAM, ALCOHOL FOAM, CO2, DRY CHEMICAL.
SPECIAL FIRE FIGHTING EQUIPMENT AND HAZARDS: AT ELEVATED TEMPERATURES SUCH AS IN FIRE CONDITIONS, POLYMERIZATION MAY TAKE PLACE. IF IT TAKES PLACE IN A CLOSED CONTAINER, THERE IS A POSSIBILITY OF A VIOLENT RUPTURE. VAPORS FORM FLAMMABLE MIXTURE WITH AIR AT ELEVATED TEMPERATURES.

SECTION 3 REACTIVITY DATA

STABILITY: STABLE. POLYMERIZES SLOWLY AT ROOM TEMPERATURE; AVOID HEAT.
INCOMPATIBILITY: ACID, BASE, OXIDIZING MATERIAL.
HAZARDOUS DECOMPOSITION PRODUCTS: ----
HAZARDOUS POLYMERIZATION: MAY OCCUR. AVOID HEAT, METAL SALTS, SUCH AS FERRIC AND ALUMINUM CHLORIDES.

SECTION 4 SPILL, LEAK, AND DISPOSAL PROCEDURES

ACTION TO TAKE FOR SPILLS (USE APPROPRIATE SAFETY EQUIPMENT): SMALL SPILL OR LEAK: REMOVE FOR DISPOSAL BY COVERING WITH SUITABLE ABSORBING AGENT, SUCH AS SAND. IF SPILL OCCURS IN A CONFINED AREA, SUCH AS A DIKE, PUMP WATER INTO AREA; VINYLTOLUENE THEN CAN BE PUMPED OFF THE

(CONTINUED ON PAGE 2)

DOW CHEMICAL U.S.A. MIDLAND MICHIGAN 48640 EMERGENCY PHONE: 517-636-4400
PRODUCT CODE: 91606
PRODUCT (CONT'D): VINYL TOLUENE (12T AND 50T INHIBITOR GRADES)MSD: 0201

SECTION 4 SPILL, LEAK, AND DISPOSAL PROCEDURES (CONTINUED)

ACTION TO TAKE FOR SPILLS (USE APPROPRIATE SAFETY EQUIPMENT): (CONTINUED)
WATER FOR RECOVERY.
DISPOSAL METHOD: INCINERATE IN PROPERLY DESIGNED FURNACE. COMPLY WITH FEDERAL, STATE AND LOCAL REGULATIONS.

SECTION 5 HEALTH HAZARD DATA

INGESTION: LOW SINGLE DOSE ORAL: LD50 (RATS) 4000 MG/KG.
EYE CONTACT: SLIGHT IRRITATION, BUT NO CORNEAL INJURY LIKELY.
SKIN CONTACT: SINGLE SHORT EXPOSURE -- NO IRRITATION LIKELY. PROLONGED OR REPEATED -- SLIGHT TO MODERATE IRRITATION EVEN A MINOR BURN POSSIBLE.
SKIN ABSORPTION: LOW TOXICITY: NO LD50 BECAUSE SKIN TESTS INDICATE NO ABSORPTION.
INHALATION: TLV: 100 PPM (1973).
EFFECTS OF OVEREXPOSURE: OBJECTIONABLE ODOR; EYE AND NASAL IRRITATION. HIGH LEVELS - ANESTHESIA. LOWER LEVELS - DIZZINESS AND DRUNKENNESS.

SECTION 6 FIRST AID--NOTE TO PHYSICIAN

FIRST AID PROCEDURES: CAUTION - NEVER GIVE FLUIDS OR INDUCE VOMITING IF PATIENT IS UNCONSCIOUS OR HAVING CONVULSIONS.
EYES: FLUSH WITH PLENTY OF WATER, GET MEDICAL ATTENTION IF ILL EFFECTS DEVELOP.
SKIN: FLUSH WITH PLENTY OF WATER, GET MEDICAL ATTENTION IF ILL EFFECTS DEVELOP.
INHALATION: IF ILL EFFECTS OCCUR, PROMPTLY REMOVE PERSON TO FRESH AIR. KEEP HIM QUIET AND WARM AND GET MEDICAL ATTENTION. IF BREATHING STOPS, START ARTIFICIAL RESPIRATION.
INGESTION: CONTAINS PETROLEUM SOLVENT. ACTIVE INGREDIENT HAS A LOW ORAL TOXICITY. DO NOT INDUCE VOMITING. GIVE BLAND FLUIDS. IMMEDIATELY CONTACT A PHYSICIAN.
NOTE TO PHYSICIAN: THIS PRODUCT CONTAINS A PETROLEUM SOLVENT. A JUDGMENT AS TO THE ADVISABILITY OF GASTRIC LAVAGE MUST BE MADE BASED UPON THE TOXICITY OF THIS PRODUCT VERSUS THE HAZARD OF ASPIRATION. IF LAVAGE IS PERFORMED, THE USE OF A CUFFED ENDOTRACHEAL TUBE IS RECOMMENDED.

SECTION 7 SPECIAL HANDLING INFORMATION

VENTILATION: NATURAL VENTILATION SUFFICIENT.
RESPIRATORY PROTECTION: UP TO 100 PPM -- NONE; 100 PPM AND ABOVE -- SELF CONTAINED BREATHING APPARATUS.
PROTECTIVE CLOTHING: CLEAN, BODY COVERING CLOTHING. PROVIDE WITH GLOVES MADE OF NEOPRENE OR NON-SOLUBLE PLASTIC.

(CONTINUED ON PAGE 3)

DOW CHEMICAL U.S.A. MIDLAND MICHIGAN 48640 EMERGENCY PHONE: 517-636-4400
PRODUCT CODE: 91606
PRODUCT (CONT'D): VINYL TOLUENE (12T AND 50T INHIBITOR GRADES)MSD: 0201

SECTION 7 SPECIAL HANDLING INFORMATION (CONTINUED)

EYE PROTECTION: SAFETY GLASSES WITHOUT SIDE SHIELDS.

SECTION 8 SPECIAL PRECAUTIONS AND ADDITIONAL INFORMATION

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: AVOID BREATHING VAPORS IF GENERATED. AVOID SKIN AND EYE CONTACT. PRACTICE CARE AND CAUTION TO AVOID EXPLOSABILITY. MONITOR AND CONTROL INHIBITOR LEVEL AT >5 PPM. CONTROL TEMPERATURE IN STORAGE BELOW 90F. VAPOR IS 1.1 TIMES HEAVIER THAN AIR AT 100F AND HAS AN IGNITION TEMPERATURE OF 914F.

ADDITIONAL INFORMATION, IF ANY: ----

LAST PAGE

THE INFORMATION HEREIN IS GIVEN IN GOOD FAITH, BUT NO WARRANTY, EXPRESSED OR IMPLIED, IS MADE.

Specialty Chemicals

EXXON CHEMICALS

Dicyclopentadiene 97

Specifications		Test Method AMS	Test Method ASTM
Appearance	Clear and Free of Suspended Matter	80.65	
Color, Pt-Co	100 Max		D 1209
COMPOSITION — Avail. Monomers[1], Wt%		180.50	
Cyclopentadiene	97.0 Min		
Methylcyclopentadiene	2.5 Max		
Acyclic Dienes	2.5 Max		
Specific Gravity, 20/20 °C	0.97-0.985		D 1298
Inhibitor (p-Tertiary Butyl Catechol) ppm	100-200	as added	

(1) Cracked Analysis

Typical Analysis			
Color Pt-Co	25		D 1290
Specific Gravity, 20/20 °C	.9765		D 1298
COMPOSITION — Avail. Monomers, Wt %		180.50	
C_5 Acyclics	1.4		
C_7 Cyclodienes	<.1		
Cyclopentadiene	98.3		
Methylcyclopentadiene	0.3		
DISTILLATION, °C			D 86
IBP	56		
10% Evaporated	157		
50% Evaporated	161		
95% Evaporated	169		
FPB	173		
Flash Point, (Tag Closed Cup) °F	66		D 56

Shipping Information	
Shipping Weight (Approx) 60°F	8.17 lb/gal
Flash Point (Tag Closed Cup) °F	35

DANGER! EXTREMELY FLAMMABLE — MAY CAUSE FLASH FIRE
MAY CAUSE EYE IRRITATION — VAPORS IRRITANT

Refer to Material Safety Data Sheet
available from Exxon Chemical Company U.S.A. at address shown below.

EXXON CHEMICAL COMPANY U.S.A. • P.O. BOX 3272, HOUSTON, TEXAS 77001
An operating division of EXXON CHEMICAL COMPANY, a division of EXXON CORPORATION

SC-78-124

PRINTED IN U.S.A.

HERCULES

MATERIAL SAFETY DATA SHEET

(Approved by U.S. Department of Labor as "Essentially Similar" to Form OSHA-20)

MSDS-07B
April 15, 1976
(Supersedes MSDS

I. PRODUCT IDENTIFICATION

CHEMICAL NAME	Para-Menthadiene	REGULAR TELEPHONE NO. 302–575-5000 EMERGENCY TELEPHONE NO. 800–424-9300	
SYNONYMS:	Dipentene, phellandrene, terpinene, terpinolene (isomer names)	CHEMICAL FAMILY:	Terpene hydrocarbon
FORMULA:	$C_{10}H_{16}$	MOLECULAR WEIGHT:	136
TRADE NAME AND SYNONYMS:	Dipentene No. 122®, Dipentene No. 213™, Solvenol® 1, and Solvenol 2		

II. HAZARDOUS INGREDIENTS

MATERIAL	%	TLV (UNITS)
Not applicable		

III. PHYSICAL DATA

BOILING POINT, 760 mm Hg	174-187°C (281-305°F)	FREEZING POINT:	Below –40°C (–40°F)
SPECIFIC GRAVITY (H_2O = 1)	0.854	VAPOR PRESSURE @	22°C: 2 mm Hg
VAPOR DENSITY (AIR = 1)	4.9	SOLUBILITY IN WATER, % BY WT. @	20°C: Slight
PERCENT VOLATILES BY VOLUME	100	EVAPORATION RATE (BUTYL ACETATE = 1)	Less than 1; slower
APPEARANCE AND ODOR	Clear, colorless liquid; pleasant, pinelike odor		

IV. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (TEST METHOD)	115-120°F (46-49°C), TCC		AUTOIGNITION TEMPERATURE	458°F (237°C)	
FLAMMABLE LIMITS IN AIR, % BY VOLUME		LOWER	0.7	UPPER	6.1
EXTINGUISHING MEDIA	Water fog, foam, carbon dioxide, dry chemical				
SPECIAL FIRE-FIGHTING PROCEDURES	Cool containers with water if exposed to fire.				
UNUSUAL FIRE AND EXPLOSION HAZARDS	Not applicable				

ORGANICS DEPARTMENT
HERCULES INCORPORATED
WILMINGTON, DELAWARE 19899

V. HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE	Not established
EFFECTS OF OVEREXPOSURE	Solvent action may defat skin
EMERGENCY AND FIRST-AID PROCEDURES	**Eyes:** Flush with water for 15 minutes, forcibly holding eyelids open. Call physician. **Skin:** Wash with soap and water. Remove contaminated clothing. **Inhalation:** Remove victim from contaminated area. Administer artificial respiration if necessary. Call physician.

VI. REACTIVITY DATA

STABILITY		CONDITIONS TO AVOID	Not applicable
UNSTABLE	STABLE		
	X		

INCOMPATIBILITY (MATERIALS TO AVOID)	Acid catalysts, strong oxidizers
HAZARDOUS DECOMPOSITION PRODUCTS	Burning liberates CO, CO_2, and smoke.

HAZARDOUS POLYMERIZATION		CONDITIONS TO AVOID	Not applicable
MAY OCCUR	WILL NOT OCCUR		
	X		

VII. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Salvage in metal container. Remove sources of ignition.
WASTE DISPOSAL METHOD	Incinerate. Waste disposal must be in accordance with local, state, and Federal regulations.

VIII. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFY TYPE)	Not applicable

VENTILATION				
	LOCAL EXHAUST		SPECIAL	
	MECHANICAL (GENERAL)	X	OTHER	

PROTECTIVE GLOVES	Solvent-resistant rubber	EYE PROTECTION	Safety glasses
OTHER PROTECTIVE EQUIPMENT	Not applicable		

IX. SPECIAL PRECAUTIONS

PRECAUTIONARY LABELING	Combustible – Keep Away From Open Flame.
OTHER HANDLING AND STORAGE CONDITIONS	Not applicable

HERCULES PRODUCT data

NUMBER 708-7

SOLVENOL® 2 Terpene Solvent

A High-Solvency Terpene Hydrocarbon

SOLVENOL® 2 is a pale yellow to near colorless liquid that has high solvency for resins, waxes, and greases. It is exceptionally effective as a softening and swelling agent for rubber. Of pinewood origin, it is a mixture of monocyclic terpenes similar to those comprising Solvenol 1, but in different proportions to one another and slightly broader in distillation range. It is comparable in solvent power with Solvenol 1 and, like the latter, is a stronger solvent than turpentine for waxes and resins.

Product Specification[1]

Specific gravity at 15.6/15.6°C	0.845-0.870
Distillation range, °C first cc	168 min
95%	195 max

(1) Hercules test methods used are available on request.

Typical Properties

Specific gravity at 15.6/15.6°C	0.860
Distillation range, °C, 5%	174
95%	183
Color, Hazen	45
Freezing point, °C	<-40
Flash point, Tag. closed cup, °F (°C)	115 (46)
Kauri-butanol value	80
Aniline point, °F (°C)	<23 (<-5)

Outstanding Characteristics

Clear, near colorless liquid; high solvent power; highly effective softening and swelling agent for natural and synthetic rubbers.

Typical Uses

Solvenol 2 is an excellent solvent for a wide variety of natural and synthetic resins, waxes, greases, and oils. Because of its softening and swelling action on rubber, Solvenol 2 is an outstanding reclaiming agent for natural and synthetic rubbers. In this application, it is generally used in conjunction with dark tackifier resins. Since Solvenol 2 does not migrate from reclaimed rubber, it contributes nonstaining properties to such compounds. Other applications for Solvenol 2 include its use as a modifier for protective coating solvents, and as a specialty solvent for a variety of uses that require a moderately volatile, high-solvent-power liquid with a pleasant odor.

(over)

Available Forms: Liquid, in tank cars, tank trucks, and in 55-gallon (208-liter) drums (389 lbs, 177 kg, net wt).

FDA Status

Solvenol 2 is cleared by the U.S. Food and Drug Administration for use in food packaging as specified in the Code of Federal Regulations, Title 21, under Section 175.105, formerly Section 121.2520.

OSHA Status

As Hercules interprets the U.S. Occupational Safety and Health Act of 1970, Solvenol 2 is a hazardous material because it is combustible. It has a TCC flash point of 115°F (46°C). A Material Safety Data Sheet is available.

TABLE 1. PHYSICAL PROPERTIES

PROPERTY	Temp. °C	STYRENE	VINYL-TOLUENE	DIVINYLBENZENE DVB-55
1. Molecular Weight		104.153	118.180	130.191
2. Boiling Point, °C at 760 mm		145.15	167.7	195.
3. Critical Density, dc g/ml		0.297		
3a. Pseudocritical Density, dc g/ml			0.272	
4. Critical Pressure, Pc atm.		37.8		
4a. Pseudocritical Pressure, Pc atm.			32.5	24.3
5. Critical Temperature, tc °C		362.1		
5a. Pseudocritical Temperature, tc °C			395.	369.
6. Critical volume, vc ml/g		3.37		
6a. Pseudocritical Volume, vc ml/g			3.68	
7. Density, g/cc	0	0.92393		
	10	0.91506		
	20	0.90620	0.8973	0.9123
	25	0.90177	0.8930	0.9084
	30	0.89734	0.8889	0.9044
	40	0.88847	0.8805	
	50	0.87960		
	60	0.87074	0.8639	
	70	0.86188		
	80	0.85301	0.8469	
	90	0.84414		
	100	0.83528		
	110	0.82642		
	120	0.81755		
	130	0.80868		
	140	0.79982		
	150			
	160			

TABLE 1. PHYSICAL PROPERTIES—Continued

PROPERTY	Temp. °C	STYRENE	VINYL-TOLUENE	DIVINYLBENZENE DVB-55
8. Density, lb/gal	15	7.60	7.52	
	20	7.56	7.49	7.61
	25	7.53	7.45	7.58
	30	7.49	7.42	7.55
9. Flammable Limits,*	not obtainable below 100°F and at atmospheric pressure			
10. Flash Point, °F Tag Closed Cup		88 (31.1°C)	123 (50.5°C)	157 (69.4°C)
11. Auto Ignition Temp., °F		914 (490°C)	1067 (575°C)	941 (505°C)
12. Freezing Point, °C		−30.6	−77	−45
13. Heat of Combustion, Δ Hc, Kcal/mole at constant pressure. All reactants and products gases	25	−1018.83	−1162.98	
14. Heat of formation, Δ Ht, Kcal/mole—gas	25	35.22	27.52	
Liquid	25	24.72		
15. Heat of fusion, Δ Hm, cal/mole		2630.		
16. Heat of polymerization, Δ Hp. Kcal/mole	25	16.68	16.0±1.0	
17. Heat of vaporization, Δ Hv, cal/g	25	100.8	101.84	
	B. Pt	85.25	83.47	83.8
18. Refractive Index, D-Line	15	1.54969		
	20	1.54682	1.54220	
	25	1.54395	1.53951	1.5585
	30	1.54108	1.53415	
	35	1.53821	1.53437	

*For other operating conditions, the literature should be consulted.

3

TABLE 1. PHYSICAL PROPERTIES—Continued

PROPERTY	Temp. °C	STYRENE	VINYL-TOLUENE	DIVINYLBENZENE DVB-55
19. Solubility in Acetone	25	∞	∞	∞
Carbon Tetrachloride	25	∞	∞	∞
Benzene	25	∞	∞	∞
Ether	25	∞	∞	∞
n-Heptane	25	∞	∞	∞
Ethanol	25	∞	∞	∞
Water, %	25	0.032	0.0089	0.0052
Water in, %	25	0.070	0.047	0.054
20. Specific heat liquid, cp cal/g°C)	0	0.4004		
	20	0.4131	0.410	
	40	0.4269	0.428	
	50			
	60	0.4421		
	70			
	80	0.4590		
	90			
	100	0.4774		
	120	0.4969		
	140	0.5174		
21. Specific heat vapor, cp cal/g°C)	25	0.2802	0.2953 (27°C)	
22. Surface Tension dynes/cm	0	34.5		
	20	32.3	31.66	
	25	31.7	31.0	32.10
	30	31.2	30.52	
	40	30.0	29.52	
	60	27.8	28.7 (30°C)	
	80	25.6		
	100	23.5	23.0	
	120	21.5		
	140	19.4		
	160			

TABLE 1. PHYSICAL PROPERTIES—Continued

PROPERTY	Temp. °C	STYRENE	VINYL-TOLUENE	DIVINYLBENZENE DVB-55
23. Vapor Pressure mm/Hg	0	1.15		
	10	2.34		
	20	4.50	1.10	
	30	8.21	2.22	
	40	14.30	4.23	
	50	23.87	7.64	
	60	38.41	13.23	
	70	59.78	22.00	
	80	90.31	35.32	
	90	132.82	54.92	
	100	190.63	82.98	
	110	267.62	122.15	
	120	368.22	175.61	
	130	497.39	247.08	
	140	660.64	340.87	
	150	864.00	461.86	
	160	1113.97	615.52	
24. Viscosity, cps	0	1.039		
	20	0.762	0.837	
	25			1.007
	40	0.588	0.644	
	60	0.469	0.518	
	80	0.385	0.428	
	100	0.324		
	120	0.279		
	140	0.243		
	160			
25. Cubical Coefficient Of Expansion	20	9.783×10^{-4}	9.361×10^{-4}	8.659×10^{-4}
	30	9.879×10^{-4}	9.450×10^{-4}	8.735×10^{-4}
	40	9.978×10^{-4}	9.540×10^{-4}	
26. Q Value		1.0	1.06	
27. E Value		−0.8	−0.78	
28. Volumetric Shrinkage upon Polymerization (Typical)		17.0%	12.6%	

APPENDIX F

roject
y LP-1604
unty Bexar

Date 8-26-80
Unit No. I
Standard Count 185

770

Rolling Pattern Study for A.S.B. & H.M.A.C.

9:30 A.M. 220°

ation & Lane	Matt	Type Of Roller (Breakdown)	Type Of Roller (Second)	Type Of Roller (Third)	Number Of Passes	C.P.M.	Densi #/ft3
1167+50	1	Tampo Roller		Stn.	1.	291	122
				Vib	2.	281	131
		Vib.		Vib.	3.	277	132
				Vib	4.	275	133
1167+50		Tampo			1.	277	132
		12 Ton			2.	273	134
		9 Wheel Pneumatic			3.	267	137.6

oject
y LP-1604
nty Bexar

Date 8-26-80
Unit No. I
Standard Count 185

7-90

Rolling Pattern Study for A.S.B. & H.M.A.C.

10:00 A.M.

ation & Lane	Matt	Type Of Roller (Breakdown)	Type Of Roller (Second)	Type Of Roller (Third)	Number Of Passes	C.P.M.	Dens #/ft3
1173+00	1	Tampo Vib. Roller		St. Vib	1st 2nd	290 271	
			Tampo Pneumatic Roller 12° Ton		1st 2nd	274 270	

oject LP-1604
ty
unty Bexar

Date 8-26-80
Unit No. I
Standard Count 185

7½%

Rolling Pattern Study for A.S.B. & H.M.A.C.

240° 11:AM

ation & Lane	Matt	Type Of Roller (Breakdown)	Type Of Roller (Second)	Type Of Roller (Third)	Number Of Passes	C.P.M.	Densit #/Ft3
1180+00	1	Tampo Vib. Roller			1.	288	128
					2.	274	133
					3.	270	136
1180+00	1	Tampo Pneumat. Roller 12 Ton			1.	280	
					2.	280	
					5		
1187+50		295°F	Doppler	240°	in mite		

oject
y LP-1604
unty Bexar

Date 8-26-80
Unit No. 1
Standard Count 185

8%

Rolling Pattern Study for A.S.B. & H.M.A.C.

Temp. 250° 1:00 P.M.

ation & Lane	Matt	Type Of Roller (Breakdown)	Type Of Roller (Second)	Type Of Roller (Third)	Number Of Passes	C.P.M.	Dens #/Ft3
1193+00	1			(Static)			
		Tampo		Sta.	1.	283	
		Vib.		Vib.	2.	278	
		Roller		Vib.	3.	274	
				Sta.	4.	272	
1192+50	1						
			Tampo		1.	276	
			Pneumatic		2.	272	
			12 Ton Roller				
1196+00					1.	276	

APPENDIX G

Local Climatological Data

Annual Summary With Comparative Data

1980

SAN ANTONIO, TEXAS

Narrative Climatological Summary

The City of San Antonio is located in the south-central portion of Texas. Northwest of the City the terrain slopes upward to the Edwards Plateau and to the southeast it slopes downward to the Gulf Coastal Plains. Soils are blackland clay and silty loam on the Plains and thin limestone soils on the Edwards Plateau.

The location of San Antonio on the edge of the Gulf Coastal Plains results in a modified subtropical climate, predominantly continental during the winter months and marine during the summer months. Normal mean temperatures range from 50.7° in January to a high of 84.7° in July. While the summer is hot, with daily maximum temperatures above 90° over 80 percent of the time, extremely high temperatures are rare, the highest on record being 107 degrees. Mild weather prevails during much of the winter months, with below-freezing temperatures occurring on an average of about 20 days each year.

San Antonio is situated between a semiarid area to the west and the coastal area of heavy precipitation to the southeast. The normal annual rainfall of 27.54 inches is sufficient for the normal production of most crops. Precipitation is fairly well distributed throughout the year with heaviest amounts during May in the spring and September in the fall. Precipitation from April through September usually occurs with thunderstorms, with fairly large amounts falling in short periods of time, while most of the winter precipitation occurs as light rain or drizzle. Thunderstorms and heavy rains have occurred in all months of the year. Hail of damaging intensity seldom occurs but light hail is frequent in connection with the springtime thunderstorms. Measurable snow occurs only once in 3 or 4 years with the greatest annual amount 7.4 inches in 1926.

Northerly winds prevail during most of the winter, while southeasterly winds from the Gulf of Mexico prevail during the summertime and may be experienced for long periods during the winter. Rather strong northerly winds occasionally occur during the winter months in connection with "northers." No tornadoes have been experienced in the immediate area.

Being located only 140 miles from the Gulf of Mexico, tropical storms occasionally affect the city with strong winds and heavy rains. The fastest mile of wind recorded, 74 m.p.h., occurred as a tropical storm moved inland east of the city in August 1942.

Relative humidity averages above 80 percent during the early morning hours most of the year, dropping to near 50 percent in the late afternoon.

San Antonio, popularly known as the place "where the sunshine spends the winter," has about 50 percent of the possible amount of sunshine during the winter months and more than 70 percent during the summer months. Skies are clear more than 35 percent of the time and cloudy about 30 percent. Air carried over San Antonio by southeasterly winds is lifted orographically, causing low stratus clouds to develop frequently during the later part of the night. These clouds usually dissipate before noon with clear skies prevailing a high percentage of the time during the afternoon.

Meteorological Data For The Current Year

Station: SAN ANTONIO, TEXAS INTERNATIONAL AIRPORT Standard time used: CENTRAL Latitude: 29° 32' N. Longitude: 98° 28' W Elevation (ground): 788 feet Year: 1980

Month	Temperature °F: Averages: Daily maximum	Daily minimum	Monthly	Extremes: Highest	Date	Lowest	Date	Degree days Base 65 °F: Heating	Cooling	Precipitation in inches: Water equivalent: Total	Greatest in 24 hrs.	Date	Snow, Ice pellets: Total	Greatest in 24 hrs.	Date	Relative humidity, pct.: Hour 00 (Local time)	Hour 06 (Local time)	Hour 12 (Local time)	Hour 18 (Local time)	Wind: Resultant: Direction	Speed m.p.h.	Average speed m.p.h.	Fastest mile: Speed m.p.h.	Direction	Date	Percent of possible sunshine	Average sky cover, tenths, sunrise to sunset	Number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperature °F: Maximum (b): 90° and above	32° and below	Minimum: 32° and below	0° and below	Average station pressure mb: Elev. 794 feet m.s.l.
JAN	63.7	41.5	52.6	80	16	26	4	386	11	0.72	0.26	20	0.0	0.0		81	84	62	61	01	4.0	9.2	29	34	30	40	7.0	7	5	19	7	0	1	7	0	0	5	0	989.2
FEB	67.4	39.9	53.7	90	19	26	10	333	14	0.74	0.26	15-16	7	T	17	76	82	54	48	03	1.2	6.8	31	35	15	56	6.6	7	7	15	9	0	1	5	1	0	10	0	990.9
MAR	74.7	48.2	61.5	91	10	19	2	163	61	0.98	0.55	27	0.0	0.0		61	71	45	38	05	1.9	10.5	35	35	1	60	7.0	8	5	18	6	0	3	2	1	0	4	0	986.5
APR	82.0	53.1	67.6	92	7	33	14	42	127	1.67	1.00	25	0.0	0.0		62	71	42	36	08	1.6	10.1	32	33	13	69	5.2	11	7	12	6	0	3	1	2	0	0	0	986.1
MAY	85.7	66.5	76.1	90	31	55	9	0	355	6.42	1.85	13-14	0.0	0.0		80	84	63	59	11	4.8	9.7	35	10	15	52	6.7	3	17	11	13	0	11	0	9	0	0	0	983.4
JUN	95.5	74.7	85.1	105	27	67	14	0	614	0.52	0.52	21	0.0	0.0		77	85	53	41	15	8.9	10.7	24	12	21	76	4.1	14	13	3	1	0	1	0	28	0	0	0	986.5
JUL	99.9	76.3	88.1	104	1	71	17	0	725	0.26	0.33	28	0.0	0.0		69	88	46	36	15	6.7	9.0	35	34	22	82	2.9	16	12	1	2	0	2	0	31	0	0	0	986.4
AUG	94.7	75.9	85.3	102	2	68	26	0	635	2.64	1.55	10-11	0.0	0.0		79	88	57	55	14	7.3	10.0	35	07	10	65	5.1	7	14	6	7	0	2	0	30	0	0	0	986.1
SEP	92.1	75.2	83.7	100	5	67	30	0	567	5.05	3.16	6-7	0.0	0.0		81	87	61	56	13	4.6	6.1	32	11	2	46	5.5	10	12	8	9	0	3	0	24	0	0	0	986.4
OCT	83.2	58.1	70.7	94	17	33	31	62	245	1.09	0.40	18	0.0	0.0		71	76	48	46	07	1.1	7.4	25	02	24	63	4.7	12	11	8	6	0	4	0	7	0	0	0	989.8
NOV	71.3	45.2	58.3	86	9	28	28	245	51	3.53	1.72	15-16	T	T		77	84	51	53	35	2.5	7.6	23	31	27	59	4.5	13	8	9	6	0	5	0	4	0	0	0	992.2
DEC	66.1	43.8	55.0	81	16	27	25	331	26	0.61	0.19	7-8	0.0	0.0		78	82	59	60	01	1.9	8.6	25	01	19	39	6.7	8	5	18	8	0	0	4	0	0	3	0	993.9
YEAR	81.4	58.2	69.8	105	JUN 27	19	MAR 2	1562	3431	24.23	3.16	SEP 6-7	T	T	NOV 25-26	74	82	53	49	12	2.4	9.7	35	07	AUG 10	50	5.5	116	120	128	60	0	31	24	132	0	26	0	988.2

Normals, Means, And Extremes

Month	Temperatures °F: Normal: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal Degree days Base 65 °F: Heating	Cooling	Precipitation in inches: Water equivalent: Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Ice pellets: Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity pct.: Hour 00 (Local time)	Hour 06 (Local time)	Hour 12 (Local time)	Hour 18 (Local time)	Wind: Mean speed m.p.h.	Prevailing direction	Fastest mile: Speed m.p.h.	Direction	Year	Pct of possible sunshine	Mean sky cover, tenths, sunrise to sunset	Mean number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperatures °F: Max. (b): 90° and above	32° and above	Min.: 32° and below	0° and below	Average station pressure mb.: Elev. 794 feet m.s.l.
(a)				39		39					38		38		38		38		38		38	38	38	38	38	15	34	34		38	38	38	38	38	38	38	38	38	38	38	38	38	38	8
JAN	61.6	39.8	50.7	89	1971	0	1949	451	8	1.66	8.52	1968	0.04	1971	3.15	1968	4.7	1949	4.7	1949	76	80	62	58	9.2	N	56	NW	1953	48	6.3	9	6	16	8	*	1	5	0	*	9	*	991.4
FEB	65.6	43.4	54.5	92	1959	6	1951	310	16	2.06	6.43	1965	0.03	1956	2.34	1965	3.5	1966	3.5	1966	75	80	57	52	9.8	NW	56	NW	1954	53	6.1	8	6	14	8	*	1	3	*	*	5	0	990.7
MAR	72.5	49.1	60.8	100	1971	19	1980	194	64	1.54	4.19	1957	0.03	1961	2.36	1945	T	1978	T	1978	71	79	53	47	10.6	SE	57	NE	1955	58	6.2	8	8	15	7	*	1	3	1	0	2	0	986.1
APR	80.3	58.8	69.6	99	1963	33	1980	31	169	2.54	9.32	1957	0.14	1955	4.88	1977	0.0		0.0		76	81	56	52	10.6	SE	57	*	1953	55	6.4	7	8	15	8	*	1	2	2	0	0	0	986.1
MAY	86.2	65.7	76.0	101	1967	46	1954	0	341	3.07	11.24	1972	0.17	1961	6.53	1972	0.0		0.0		81	86	59	55	10.2	SE	73	NW	1946	56	6.4	6	11	14	8	0	1	4	9	0	0	0	984.2
JUN	92.4	72.0	82.2	105	1980	53	1964	0	516	2.79	10.44	1973	0.01	1967	6.18	1951	0.0		0.0		80	88	56	51	10.1	SE	59	E	1953	68	5.5	7	16	7	6	0	*	4	*	22	0	0	0	986.3
JUL	95.0	72.8	84.7	106	1954	62	1967	0	611	1.69	8.19	1942	T	1944	6.97	1958	0.0		0.0		75	87	51	45	9.2	SSE	52	NE	1943	75	5.0	9	15	7	4	*	*	4	*	28	0	0	0	987.3
AUG	95.9	73.4	84.7	106	1962	61	1966	0	611	2.41	11.14	1974	0.00	1952	5.57	1950	0.0		0.0		74	86	51	46	8.6	SE	74	NE	1942	74	4.9	10	15	6	5	0	0	4	*	28	0	0	0	987.4
SEP	89.8	68.8	79.3	102	1951	41	1942	0	429	3.71	15.78	1946	0.06	1947	7.28	1973	0.0		0.0		78	86	55	52	8.5	SE	49	NE	1952	67	5.2	10	12	8	7	0	0	4	*	17	0	0	0	986.8
OCT	81.8	59.2	70.5	98	1979	33	1980	32	202	2.84	9.56	1942	T	1952	5.29	1942	0.0		0.0		77	84	53	52	8.4	N	43	NW	1945	65	4.8	12	10	9	6	0	0	2	2	*	0	0	989.5
NOV	71.1	48.2	59.7	91	1962	21	1976	179	20	1.77	6.01	1977	T	1966	4.87	1977	0.3	1957	0.3	1957	76	81	55	56	8.9	N	43	N	1950	56	5.4	11	7	12	6	0	0	2	3	*	0	2	0	990.6
DEC	64.6	41.8	53.2	90	1955	14	1950	373	7	1.46	4.51	1965	0.03	1950	2.89	1944	0.2	1964	0.2	1964	76	80	57	57	8.6	N	48	NW	1947	51	6.0	10	6	15	7	0	1	5	*	0	6	0	991.2
YR	79.8	57.8	68.8	106	AUG 1962	0	JAN 1949	1570	2994	27.54	15.78	SEP 1946	0.00	AUG 1952	7.28	SEP 1973	4.7	JAN 1949	4.7	JAN 1949	76	83	55	52	9.4	SE	74	NE	AUG 1942	61	5.7	107	120	138	81	*	36	23	111	*	23	*	988.1

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 107 in August 1909; maximum monthly snowfall 6.4 in January 1926; maximum snowfall in 24 hours 5.0 in January 1940.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

Average Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1941	55.7	52.#	56.1	68.6	76.3	81.0	84.4	84.4	81.6	75.8	59.1	54.9	69.1
#1942	50.2	53.8	61.4	69.6	76.0	83.4	81.2	82.7	75.6	69.6	63.0	55.0	68.5
1943	50.2	58.4	58.3	71.8	77.2	81.2	83.4	85.8	76.4	67.6	57.1	50.5	69.2
1944	50.3	57.0	60.4	69.0	71.8	81.3	84.4	84.0	78.0	69.7	60.2	49.0	67.8
1945	51.4	55.6	67.2	67.2	75.2	82.4	84.2	84.6	80.2	68.4	63.8	50.8	69.2
1946	49.2	55.6	63.0	71.1	75.4	80.0	84.4	83.8	78.2	72.4	60.4	55.8	69.1
1947	48.4	48.6	56.0	68.2	75.2	83.9	84.2	83.3	80.4	76.3	57.4	53.4	67.9
1948	45.4	52.6	60.4	72.8	78.2	84.4	85.4	85.2	77.7	70.4	57.7	55.8	68.8
1949	46.5	57.4	62.2	64.6	78.4	81.0	83.6	82.5	80.8	70.6	62.6	55.8	68.8
1950	58.4	56.7	60.6	67.1	76.9	80.7	84.2	82.5	79.5	73.3	59.4	52.8	69.4
1951	50.5	54.3	62.6	68.9	75.4	81.9	86.7	87.1	80.5	72.9	58.1	55.2	69.5
1952	59.5	58.6	60.7	65.7	73.3	81.9	83.6	86.2	77.5	65.6	58.4	51.6	69.6
1953	55.9	54.8	67.9	69.2	76.0	85.0	86.1	84.6	78.3	71.2	59.0	49.4	69.8
1954	54.9	60.4	62.3	73.7	74.9	83.5	85.8	86.7	82.6	73.1	60.6	58.3	71.4
1955	53.1	56.4	69.4	73.8	78.9	81.4	84.5	84.6	81.9	70.5	59.8	53.5	70.2
1956	52.1	57.1	63.3	69.7	78.9	84.7	85.5	84.8	80.0	73.0	57.8	56.9	70.3
1957	53.3	62.9	61.9	66.3	73.4	81.0	85.7	86.0	77.8	66.9	57.1	55.5	69.0
1958	50.1	50.0	55.8	67.7	75.1	82.8	84.6	84.8	79.2	67.7	60.4	50.1	67.4
1959	48.9	54.0	60.0	65.9	77.1	82.9	84.0	84.4	81.4	70.4	53.3	54.0	68.0
1960	50.1	49.9	56.1	69.7	74.1	83.3	84.2	83.6	78.6	75.3	62.2	50.1	67.9
1961	47.9	55.9	65.7	68.5	78.5	81.3	82.6	82.5	80.5	71.1	58.0	54.2	68.9
1962	45.9	62.8	59.1	69.7	77.9	82.3	86.9	87.5	80.9	75.5	60.4	52.2	70.1
1963	46.2	52.6	65.6	74.6	77.7	83.4	85.4	85.7	81.1	74.1	62.4	45.7	69.6
1964	51.0	49.8	61.5	70.5	77.6	82.4	86.3	86.2	80.0	66.4	62.6	52.3	69.9
1965	54.4	49.8	54.9	71.6	75.0	81.6	84.9	84.0	80.7	66.8	64.5	55.5	68.6
1966	45.4	49.8	60.0	68.6	73.5	78.8	84.2	81.9	77.5	67.0	63.0	50.7	66.7
1967	50.2	51.8	66.9	76.6	76.6	84.5	85.5	82.7	75.5	66.9	60.5	51.0	69.0
1968	49.8	48.3	58.0	68.1	75.3	80.5	82.7	84.2	76.0	72.2	56.4	50.7	66.8
1969	52.5	53.6	54.9	69.0	73.5	81.2	86.5	85.7	79.6	69.8	58.1	55.1	68.3
1970	45.6	54.8	56.8	70.2	72.9	80.7	84.0	85.7	81.1	67.7	58.0	60.1	68.1
1971	56.0	57.4	64.6	69.4	78.1	83.6	85.9	81.2	80.1	73.9	63.2	57.2	70.9
1972	52.8	56.7	66.3	73.7	72.8	80.3	82.2	82.1	82.0	71.9	54.0	50.3	68.8
1973	47.2	51.9	66.1	66.0	74.7	79.2	83.2	82.1	79.3	72.5	65.8	52.2	69.4
1974	51.0	56.5	67.9	69.7	77.3	79.4	83.0	81.2	72.3	68.2	57.3	50.9	67.9
1975	53.2	53.5	61.4	68.4	73.5	80.0	80.9	81.7	76.0	71.1	60.3	53.1	67.8
1976	49.6	61.2	63.8	68.9	71.3	79.8	79.8	81.6	77.5	61.1	52.1	49.9	66.4
1977	44.1	52.8	61.8	66.9	74.8	81.5	84.9	84.7	82.3	71.2	61.4	51.4	68.3
1978	43.4	46.4	59.6	68.9	77.1	82.7	86.1	83.1	78.5	69.3	62.4	51.2	67.5
1979	43.7	52.4	63.3	69.7	73.9	80.9	84.7	83.1	78.7	74.7	58.2	55.4	68.2
1980	52.6	51.7	61.5	67.6	76.1	85.1	88.1	85.3	83.7	70.7	58.3	55.0	69.8
RECORD MEAN	51.8	55.3	62.2	69.4	75.4	81.6	84.0	84.0	79.3	70.8	60.4	53.7	69.0
MAX	62.2	66.2	73.4	80.0	85.4	91.6	94.4	94.7	89.4	81.7	71.0	64.1	79.5
MIN	41.4	44.3	51.0	58.7	65.4	71.6	73.5	73.3	69.2	59.9	49.8	43.3	58.5

Heating Degree Days

SAN ANTONIO, TX

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1960-61	0	0	0	17	138	457	523	272	82	63	0	0	1552
1961-62	0	0	0	19	223	751	586	108	206	27	0	0	1520
1962-63	0	0	0	9	164	393	575	349	87	17	3	0	1597
1963-64	0	0	0	0	141	592	428	434	143	23	0	0	1761
1964-65	0	0	0	41	155	414	346	419	327	15	0	0	1717
1965-66	0	0	2	62	64	301	607	426	142	39	5	0	1648
1966-67	0	0	0	57	131	456	470	368	82	0	0	0	1560
1967-68	0	0	0	44	164	429	477	478	254	19	0	0	1857
1968-69	0	0	0	9	278	437	394	319	315	5	3	0	1760
1969-70	0	0	0	52	253	299	599	282	266	45	7	0	1803
1970-71	0	0	1	72	247	201	282	239	134	52	1	0	1229
1971-72	0	0	1	0	129	266	382	263	61	7	0	0	1109
1972-73	0	0	0	29	334	457	551	362	29	94	1	0	1857
1973-74	0	0	0	4	45	391	437	257	74	39	5	0	1287
1974-75	0	0	2	19	260	433	389	316	152	41	0	0	1812
1975-76	0	0	1	21	214	394	472	166	143	11	2	0	1424
1976-77	0	0	0	167	382	461	643	336	144	32	0	0	2155
1977-78	0	0	0	19	136	361	667	521	192	27	4	0	1928
1978-79	0	0	0	12	152	417	657	356	139	20	4	0	1757
1979-80	0	0	0	15	243	304	386	535	183	42	0	0	1858
1980-81	0	0	0	62	245	331							

Cooling Degree Days

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1969	11	5	8	131	273	494	683	652	448	207	53	21	2969
1970	3	3	20	208	259	478	592	651	495	163	40	57	2967
1971	14	34	130	189	414	564	658	609	459	261	81	31	3366
1972	11	31	109	278	252	465	542	539	515	249	12	6	3009
1973	8	0	69	129	310	431	570	536	437	242	114	0	2846
1974	11	22	171	188	387	439	568	506	229	124	24	5	2664
1975	29	1	51	151	273	457	502	524	337	217	80	30	2652
1976	3	62	113	136	202	451	467	521	383	45	0	0	2383
1977	0	7	52	98	311	502	620	618	525	218	38	5	2990
1978	3	7	10	157	384	537	660	567	410	154	79	11	2994
1979	3	13	69	169	285	482	619	570	414	322	42	13	2998
1980	11	14	61	127	355	614	725	635	567	245	51	26	3431

Precipitation

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1941	2.14	1.86	2.95	4.56	2.50	2.03	0.62	0.23	4.88	3.13	0.47	0.97	26.34
#1942	0.13	2.01	0.29	3.48	2.19	1.95	8.19	1.88	7.67	9.56	0.47	0.64	38.46
1943	0.73	0.09	1.58	1.48	2.56	1.91	3.72	0.78	4.34	0.17	1.95	1.20	20.51
1944	3.49	1.68	3.72	0.94	6.76	1.64	T	4.32	1.30	1.52	3.66	4.16	33.19
1945	2.97	3.90	2.73	2.91	1.24	5.31	1.19	1.19	3.00	3.49	1.35	1.18	30.46
1946	3.64	2.24	1.75	5.54	3.47	2.92	0.20	4.03	15.78	1.31	1.86	2.43	45.17
1947	2.14	0.29	1.46	0.30	3.32	0.31	1.00	5.34	0.06	0.19	1.01	1.90	17.32
1948	0.61	1.86	0.59	1.40	1.59	2.96	2.35	5.83	1.98	3.24	1.00	0.23	23.64
1949	2.91	2.98	2.27	8.99	0.85	8.26	2.24	1.03	0.78	7.58	0.13	2.79	40.81
1950	0.32	1.43	0.24	3.42	2.43	1.03	1.60	6.15	3.02	0.08	0.13	0.03	19.86
1951	0.25	2.43	2.76	0.93	4.44	7.07	0.51	0.06	3.75	1.44	0.67	0.13	24.44
1952	0.81	2.01	2.34	3.40	1.91	1.86	2.75	0.00	3.02	T	4.47	3.67	26.24
1953	0.41	0.90	0.53	2.08	1.00	2.19	0.01	3.12	2.48	3.06	0.34	1.44	17.56
1954	0.51	0.03	0.03	1.94	1.46	2.71	1.25	1.05	0.52	1.98	2.02	0.20	13.70
1955	1.45	2.33	1.40	0.14	4.44	2.88	1.32	0.81	0.79	0.39	1.57	0.66	18.18
1956	0.81	0.85	0.27	0.49	3.07	0.27	0.53	3.94	0.62	1.23	1.13	1.10	14.31
1957	0.51	2.53	4.19	9.32	8.22	3.49	0.73	0.21	11.10	4.71	2.90	0.92	48.83
1958	4.57	3.88	1.08	1.32	1.94	3.39	7.39	0.45	8.36	5.43	0.77	1.07	39.69
1959	0.52	2.50	0.13	2.55	2.43	1.32	1.48	3.05	1.72	5.11	2.17	1.52	24.50
1960	0.76	1.22	1.65	2.08	1.21	2.70	1.31	5.96	0.76	7.84	1.30	2.97	29.76
1961	0.68	1.79	0.03	0.32	0.17	7.87	7.04	0.15	2.24	3.39	2.09	0.70	26.47
1962	0.48	0.90	0.91	4.02	1.31	2.44	0.13	1.57	2.69	2.19	4.97	2.29	23.90
1963	0.27	3.59	0.21	1.88	3.03	2.28	0.03	0.63	1.11	2.75	1.93	0.94	18.65
1964	3.40	1.89	1.73	1.16	1.79	4.88	0.02	5.19	4.15	1.64	4.81	1.22	31.88
1965	2.40	6.43	2.30	1.97	8.18	2.42	0.08	1.65	3.13	2.69	0.89	4.51	36.65
1966	1.47	2.30	1.14	3.20	3.53	1.78	0.06	4.28	2.13	1.11	T	0.44	21.44
1967	0.18	0.48	2.18	0.94	2.22	0.01	2.12	3.17	11.16	2.00	3.42	1.38	29.26
1968	8.52	1.85	1.27	1.92	2.82	2.63	1.59	0.94	2.99	0.69	4.58	0.66	30.40
1969	1.76	2.90	2.35	2.46	4.61	2.32	0.36	4.19	1.32	5.85	1.02	2.28	31.42
1970	1.10	2.66	1.98	1.13	7.30	0.89	0.91	0.95	4.35	1.31	0.01	0.15	22.74
1971	0.04	0.81	0.04	1.39	1.52	2.74	1.05	9.42	4.57	4.62	2.74	2.86	31.80
1972	1.35	0.40	0.13	1.94	11.24	2.86	3.13	4.24	1.40	1.99	2.37	0.44	31.49
1973	2.77	2.76	1.58	5.41	2.73	10.44	6.91	1.29	13.09	4.85	0.29	0.16	52.28
1974	1.36	0.04	0.94	2.18	4.24	1.02	1.28	11.14	3.85	4.09	5.39	1.43	37.00
1975	1.04	3.30	0.52	2.69	6.91	4.60	1.06	1.28	0.51	2.25	0.03	1.48	25.67
1976	0.56	0.13	1.20	5.67	5.80	1.61	5.39	2.09	3.79	8.48	2.46	1.95	39.13
1977	3.10	0.91	0.88	8.80	1.62	2.26	0.10	0.06	2.11	3.47	6.01	0.32	29.64
1978	0.68	1.76	1.71	3.62	2.45	3.96	1.43	4.97	8.86	0.55	4.91	1.09	35.99
1979	4.07	1.38	3.55	5.34	1.98	5.59	7.38	2.09	0.86	0.11	1.43	2.86	36.64
1980	0.72	0.74	0.98	1.67	6.42	0.52	0.26	2.64	5.05	1.09	3.53	0.61	24.23
RECORD MEAN	1.60	1.66	1.63	3.00	3.40	2.84	2.05	2.43	3.26	2.43	1.91	1.69	27.85

Snowfall

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1941-42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1942-43	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1943-44	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.1
1944-45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1945-46	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1946-47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T	T	0.0	0.0	T
1947-48	0.0	0.0	0.0	0.0	0.0	T	T	0.0	T	0.0	0.0	0.0	T
1948-49	0.0	0.0	0.0	0.0	T	0.0	4.7	0.0	0.0	0.0	0.0	0.0	4.7
1949-50	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	0.0	T
1950-51	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.4	0.0	0.0	0.0	0.0	1.3
1951-52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1952-53	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1953-54	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1954-55	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1955-56	0.0	0.0	0.0	0.0	T	0.4	0.0	0.0	0.0	0.0	0.0	0.0	T
1956-57	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1957-58	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	T	0.0	0.0	T
1958-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	T
1959-60	0.0	0.0	0.0	0.0	T	0.0	0.0	T	0.0	0.0	0.0	0.0	T
1960-61	0.0	0.0	0.0	0.0	0.0	T	T	T	0.0	0.0	0.0	0.0	T
1961-62	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962-63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	T
1963-64	0.0	0.0	0.0	0.0	0.0	T	T	2.0	0.0	0.0	0.0	0.0	2.0
1964-65	0.0	0.0	0.0	0.0	0.0	0.2	0.0	T	T	0.0	0.0	0.0	0.2
1965-66	0.0	0.0	0.0	0.0	0.0	0.0	T	3.5	0.0	0.0	0.0	0.0	3.5
1966-67	0.0	0.0	0.0	0.0	0.0	0.0	T	T	0.0	0.0	0.0	0.0	T
1967-68	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	T
1968-69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1969-70	0.0	0.0	0.0	0.0	0.0	T	T	T	T	0.0	0.0	0.0	T
1970-71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971-72	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1972-73	0.0	0.0	0.0	0.0	0.0	T	0.8	2.1	0.0	0.0	0.0	0.0	2.9
1973-74	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1974-75	0.0	0.0	0.0	0.0	0.0	T	T	T	0.0	0.0	0.0	0.0	T
1975-76	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1976-77	0.0	0.0	0.0	0.0	T	T	0.0	0.0	0.0	0.0	0.0	0.0	T
1977-78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	T
1978-79	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1979-80	0.0	0.0	0.0	0.0	T	0.0	0.0	T	0.0	0.0	0.0	0.0	T
1980-81	0.0	0.0	0.0	0.0	T	0.0							
RECORD MEAN	0.0	0.0	0.0	0.0	T	T	0.2	0.2	T	0.0	0.0	0.0	0.4

# Indicates a station move or relocation of instruments. See Station Location table.

Record mean values above are means through the current year for the period beginning in 1885 for temperature and precipitation, 1943 for snow. Data are from City Office locations through 1940 and Airport thereafter.

STATION LOCATION

SAN ANTONIO, TEXAS

Location	Occupied from	Occupied to	Airline distance and direction from previous location	Latitude North	Longitude West	Elevation above Ground: See level	Elevation above Ground: Ground at temperature site	Elevation above Ground: Wind instruments	Elevation above Ground: Extreme thermometers	Elevation above Ground: Psychrometer	Elevation above Ground: Sunshine Switch	Elevation above Ground: Tipping bucket rain gage	Elevation above Ground: Weighing rain gage	Elevation above Ground: 8" rain gage	Elevation above Ground: Hygrothermometer	Automatic Observing Equipment *	* Type M = AMOS T = AUTOB	Remarks
CITY																		
Headquarters Building Fort Sam Houston, Texas	3/07/85	7/15/91		29° 27'	98° 28'					17				1				Station established by Signal Corps.
Dulling Building Commerce & Alamo Sts.	7/15/91	2/01/92	2.3 mi. SW	29° 27'	98° 28'					58				50				Records taken over by Weather Bureau.
Alamo Insurance Building Navarro Street	2/01/92	7/01/95	0.2 mi.WNW	29° 27'	98° 28'			75	66	66				60				
Maverick Building Alamo Plaza & Houston Streets	7/01/95	5/01/00	0.1 mi. E	29° 27'	98° 28'		667	104	95	95				81				
Hicks Building Avenue C & East Houston Street	5/01/00	6/30/14	0.2 mi. E	29° 27'	98° 28'		660	91	80	80		72		72				Tipping Bucket rain gage and sunshine recorder installed 11/7/02.
State Bank & Trust Bldg. 313 East Houston Street	6/30/14	7/01/30	0.3 mi. N	29° 27'	98° 28'		649	132	119	119		122		112				Thermometers and rain gages 10 feet lower prior to 5/12/16.
Alamo Nat'l. Bank Bldg. 306 West Commerce St.	7/01/30	10/24/37	0.5 mi.WSW	29° 27'	98° 28'		646	301	243	243		235		235				
Federal Building Alamo Plaza & Houston St.	10/24/37	1/02/41	0.6 mi.ENE	29° 27'	98° 28'		652	301	111	111		103		103				Wind instruments left on roof of Alamo National Bank Building.
AIRPORT																		
Administration Building Stinson Field 7 miles SE of PO	12/27/38	1/02/41		29° 20'	98° 28'		567	59	b28	28				a3				a - 27 feet to 7/1/39. b - Installed 7/1/39 Record observations transferred to Airport 7/1/39.
Administration Building Stinson Field	1/02/41	7/14/42		29° 20'	98° 28'		567	63	7	7		28		28				WBO and WBAS consolidated at Airport.
East Lean-To, Hangar #2 San Antonio Airport	7/14/42	8/15/53	12.8 mi. N	29° 32'	98° 28'		782	51	8	8		4		4				a - 33 feet to 9/1/61.
Feeder Lines Terminal Building, San Antonio International Airport	8/15/53	5/24/72	1200 ft.NW	29° 32'	98° 28'		c788	a23	5	5		4		3	b4			b - Telepsychrometer(4') 10/17/48-removed 1/20/69. Hygro. comp. 1000' NE of thermometer site 4/1/64. c - 792 feet to 4/1/64.
North Crown Building 830 N.E. Loop 410 International Airport	5/24/72	Present	1.1 mi. SE	29° 32'	98° 28'		788	23	NA	NA	80	74	f74	74	d4	NA		d - Same site as prior to 5/24/72. f - Added 9/1/76.

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I certify that this is an official publication of the National Oceanic and Atmospheric Administration, and is compiled from records on file at the National Climatic Center, Asheville, North Carolina 28801.

Daniel B. Mitchell
Director, National Climatic Center

USCOMM-NOAA-ASHEVILLE - 1275

1763

AUGUST 1980
SAN ANTONIO, TEXAS
NAT WEATHER SERVICE FCST OFC
INTERNATIONAL AIRPORT

Local Climatological Data

MONTHLY SUMMARY

LATITUDE 29 ° 32 'N LONGITUDE 98 ° 28 'W ELEVATION (GROUND) 788 FT. STANDARD TIME USED: CENTRAL WBAN #12921

DATE	TEMPERATURE °F MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	AVERAGE DEW POINT	DEGREE DAYS BASE 65° HEATING (SEASON BEGINS WITH JULY)	COOLING (SEASON BEGINS WITH JAN.)	WEATHER TYPES ON DATES OF OCCURRENCE 1 FOG 2 HEAVY FOG 3 THUNDERSTORM 4 ICE PELLETS 5 HAIL 6 GLAZE 7 DUSTSTORM 8 SMOKE, HAZE 9 BLOWING SNOW	SNOW, ICE PELLETS OR ICE ON GROUND AT 06 AM IN.	PRECIPITATION WATER EQUIVALENT IN	SNOW, ICE PELLETS IN.	AVG. STATION PRESSURE IN. ELEV. 794 FEET M.S.L.	WIND RESULTANT DIR.	WIND RESULTANT SPEED M.P.H.	WIND AVERAGE SPEED M.P.H.	WIND FASTEST MILE SPEED M.P.H.	WIND FASTEST MILE DIRECTION	SUNSHINE MINUTES	SUNSHINE PERCENT OF POSSIBLE	SKY COVER TENTHS SUNRISE TO SUNSET	SKY COVER TENTHS MIDNIGHT TO MIDNIGHT	DATE
1	98	78	88	3	65	0	23		0	0	0	29.19	16	8.1	8.5	13	14	741	91	1	1	1
2	102*	79	91*	6	70	0	26		0	0	0	29.08	16	10.7	11.4	18	14	696	86	4	3	2
3	99	80	90	4	72	0	25		0	0	0	29.00	15	13.2	13.5	18	14	455	56	6	6	3
4	99	81	90	4	72	0	25		0	0	0	28.96	15	14.3	14.5	20	14	491	61	8	7	4
5	97	82	90	4	73	0	25		0	0	0	29.07	15	12.8	13.2	18	13	518	64	6	6	5
6	97	78	88	2	73	0	23	3	0	.27	0	29.19	14	9.0	10.6	20	11	492	61	6	6	6
7	95	73	84	-2	71	0	19		0	.07	0	29.20	09	4.8	6.0	17	13	543	67	5	4	7
8	99	75	87	2	69	0	22		0	0	0	29.12	09	7.4	7.9	17	11	654	81	5	5	8
9	92	79	86	1	69	0	21	3	0	.43	0	29.01	05	10.7	11.7	21	10	125	16	10	10	9
10	81	75	78*	-7	73	0	13		0	1.49	0	28.92	05	17.8	18.4	35	07	0	0	10	10	10
11	92	76	84	-1	74	0	19	1	0	.08	0	29.07	10	13.4	13.5	18	09	259	32	9	10	11
12	94	77	86	1	74	0	21		0	0	0	29.18	12	8.2	8.6	14	11	506	63	8	8	12
13	94	77	86	1	74	0	21	1	0	T	0	29.14	16	8.3	8.8	14	13	500	63	6	6	13
14	97	77	87	2	73	0	22		0	0	0	29.09	16	9.8	11.4	14	12	540	68	5	5	14
15	92	78	85	0	75	0	20		0	0	0	29.03	14	9.0	9.5	14	15	485	61	6	7	15
16	93	77	85	0	75	0	20		0	.03	0	29.05	15	12.4	12.9	16	12	411	52	7	8	16
17	93	77	85	0	75	0	20	1	0	T	0	29.12	15	10.6	10.9	15	13	336	43	8	9	17
18	92	77	85	0	73	0	20		0	0	0	29.16	15	12.3	12.5	15	14	548	69	5	6	18
19	93	77	85	0	75	0	20		0	0	0	29.15	16	13.3	13.7	21	12	479	61	6	7	19
20	92	75	84	-1	71	0	19		0	0	0	29.12	16	9.4	9.9	13	23	586	75	4	4	20
21	94	75	85	0	72	0	20		0	0	0	29.13	17	5.8	6.3	10	16	741	95	0	2	21
22	96	71	84	0	71	0	19		0	0	0	29.16	18	3.5	6.5	12	16	750	96	1	0	22
23	96	72	84	0	71	0	19		0	0	0	29.21	12	2.3	6.3	13	14	756	97	0	0	23
24	98	74	86	2	69	0	21		0	0	0	29.17	21	2.7	6.0	12	06	535	69	5	3	24
25	96	72	84	0	70	0	19		0	.27	0	29.15	12	3.4	6.3	10	13	504	65	2	1	25
26	94	68*	81	-3	64	0	16		0	0	0	29.18	14	3.7	7.2	13	16	703	91	0	1	26
27	94	72	83	-1	71	0	18	1 8	0	0	0	29.20	12	5.0	6.0	23	06	584	76	3	2	27
28	93	71	82	-1	70	0	17	1 8	0	0	0	29.23	14	5.0	6.3	13	14	582	75	6	4	28
29	94	76	85	2	72	0	20		0	0	0	29.21	15	5.8	7.2	13	11	527	69	5	6	29
30	95	76	86	3	73	0	21		0	0	0	29.15	16	10.4	11.1	17	16	446	58	5	5	30
31	94	77	86	3	73	0	21		0	T	0	29.12	16	12.3	12.7	31	19	442	58	5	6	31
	SUM 2935	SUM 2352				TOTAL 0	TOTAL 635	NUMBER OF DAYS		TOTAL 2.64	TOTAL 0	29.12	FOR THE MONTH: 14	7.3	10.0	31	07	TOTAL 15944	% FOR MONTH 157	SUM	SUM	
	AVG. 94.7	AVG. 75.9	AVG. 85.3	DEP. 0.6	AVG. 72	DEP. 0	DEP. 74	PRECIPITATION >.01 INCH 7		DEP. 0.23						DATE: 10		POSSIBLE 24520	POSSIBLE MONTH 65	AVG. 5.1	AVG. 5.1	

NUMBER OF DAYS				SEASON TO DATE	
MAXIMUM TEMP.		MINIMUM TEMP.		TOTAL	TOTAL
≥ 90 °	≤ 32 °	≤ 32 °	≤ 0 °	DEP.	DEP.
30	0	0	0	0	206

SNOW, ICE PELLETS	
> 1.0 INCH	0
THUNDERSTORMS	2
HEAVY FOG	0
CLEAR 7	PARTLY CLOUDY 16

GREATEST IN 24 HOURS AND DATES		GREATEST DEPTH ON GROUND OF SNOW, ICE PELLETS OR ICE AND DATE
PRECIPITATION	SNOW, ICE PELLETS	
1.55 10-11	0	0

CLOUDY 6

* EXTREME FOR THE MONTH - LAST OCCURRENCE IF MORE THAN ONE.
T TRACE AMOUNT
+ ALSO ON AN EARLIER DATE, OR DATES.
HEAVY FOG: - VISIBILITY 1/4 MILE OR LESS.
FIGURES FOR WIND DIRECTIONS ARE TENS OF DEGREES CLOCKWISE FROM TRUE NORTH. 00 = CALM. DATA IN COLS. 6 AND 12-15 ARE BASED ON 7 OR MORE OBSERVATIONS PER DAY AT 3-HOUR INTERVALS. FASTEST MILE WIND SPEEDS ARE FASTEST OBSERVED ONE-MINUTE VALUES WHEN DIRECTIONS ARE IN TENS OF DEGREES. THE / WITH THE DIRECTION INDICATES PEAK GUST SPEED.
ANY ERRORS DETECTED WILL BE CORRECTED AND CHANGES IN SUMMARY DATA WILL BE ANNOTATED IN THE ANNUAL SUMMARY

SUMMARY BY HOURS

HOUR LOCAL TIME	AVERAGES SKY COVER TENTHS	STATION PRESSURE IN.	TEMPERATURE AIR °F	TEMPERATURE WET BULB °F	TEMPERATURE DEW PT. °F	RELATIVE HUMIDITY %	WIND SPEED M.P.H.	RESULTANT WIND DIRECTION	RESULTANT WIND SPEED M.P.H.
00	5	29.14	80	75	73	79	8.9	14	7.2
03	6	29.13	78	74	73	86	7.9	14	4.4
06	7	29.14	77	74	73	88	7.8	14	3.6
09	6	29.17	81	76	74	79	9.3	15	6.5
12	5	29.15	88	76	71	57	10.8	15	7.6
15	5	29.09	92	76	69	48	12.2	14	9.1
18	4	29.06	89	75	70	55	12.4	13	10.8
21	3	29.10	84	75	71	67	10.5	13	9.3

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A. M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	P. M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	DATE
1																									1
2																									2
3																									3
4																									4
5																									5
6														T	.02	.08		.14	.03						6
7																.06	.01								7
8																									8
9															.40	.03				T					9
10						.02	.05	.05	.02	.05	.32	.07	.02	.07	.08	.09	.10	.16	.03	.16	.04	.01	.10	.01	.03	10
11	.01	.03	.02	T	T							T		01	01										11
12																									12
13							T	T																	13
14																									14
15																									15
16																				.02	.01	T	T		16
17										T															17
18																									18
19																									19
20																									20
21																									21
22																									22
23																									23
24																									24
25															T		.27								25
26																									26
27																									27
28																									28
29																									29
30																									30
31																T	T								31

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I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND IS COMPILED FROM RECORDS ON FILE AT THE NATIONAL CLIMATIC CENTER, ASHEVILLE, NORTH CAROLINA 28801.

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / ENVIRONMENTAL DATA AND INFORMATION SERVICE

Daniel B. Mitchell
DIRECTOR, NATIONAL CLIMATIC CENTER

USCOMM--NOAA--ASHEVILLE

AUGUST 1980 SAN ANTONIO, TEXAS

OBSERVATIONS AT 3-HOUR INTERVALS

HOUR	SKY COVER TENTHS	CEILING HNDS OF FT.	VISIBILITY WHOLE MILES	VISIBILITY 16THS MILE	WEATHER	TEMPERATURE AIR °F	TEMPERATURE WET BULB °F	TEMPERATURE DEW PT. °F	REL. HUM. %	WIND DIR	WIND SPEED KNOTS
DAY 01											
00	0	UNL	12			84	72	66	55	13	7
03	0	UNL	10			79	72	69	72	16	5
06	6	13	8			78	73	71	79	18	6
09	0	UNL	8			83	74	70	65	16	8
12	0	UNL	10			91	73	65	42	18	9
15	0	UNL	12			95	70	57	28	16	7
18	0	UNL	15			96	69	54	25	14	6
21	0	UNL	12			90	72	64	42	14	11
DAY 02											
00	0	UNL	10			82	76	73	74	15	9
03	5	UNL	10			80	76	74	82	15	8
06	9	13	10			80	76	74	82	16	8
09	5	UNL	15			82	76	73	74	18	11
12	1	UNL	20			93	76	69	46	19	12
15	1	UNL	20			100	74	60	27	17	11
18	2	UNL	20			97	73	62	31	15	9
21	0	UNL	12			88	78	74	63	13	11
DAY 03											
00	0	UNL	12			83	76	73	72	16	11
03	0	UNL	10			81	76	74	79	14	9
06	8	14	10			80	76	74	82	13	8
09	5	UNL	15			83	76	73	72	16	12
12	0	38	12			93	77	70	47	16	13
15	4	UNL	12			97	76	67	38	16	13
18	2	UNL	12			92	78	72	52	13	15
21	3	UNL	12			86	77	74	68	14	13
DAY 04											
00	10	16	12			84	77	75	74	15	13
03	8	19	10			82	76	73	74	16	11
06	9	16	10			82	76	74	77	16	11
09	7	23	8			83	75	72	70	15	12
12	9	UNL	8			91	76	69	49	17	14
15	9	200	10			96	76	68	40	15	13
18	9	120	12			93	78	72	51	14	16
21	0	UNL	12			87	76	72	61	14	11
DAY 05											
00	3	UNL	12			80	77	75	77	16	10
03	3	14	10			82	77	75	79	14	9
06	7	250	8			82	77	75	79	17	10
09	8	120	10			84	77	75	74	16	13
12	7	250	12			91	77	71	52	16	13
15	6	250	12			94	76	69	44	15	13
18	2	UNL	12			92	77	71	50	13	15
21	0	UNL	15			86	75	70	59	13	9
DAY 06											
00	7	16	12			81	77	75	77	13	10
03	9	10	10			81	77	76	85	14	10
06	7	10	8			81	77	76	85	12	6
09	10	26	12			84	76	73	70	16	8
12	6	40	20			91	76	69	49	14	12
15	9	50	20		RW	83	76	73	72	30	5
18	7	250	12		TRW	83	75	72	70	13	15
21	2	UNL	20			81	74	71	72	12	8
DAY 07											
00	0	UNL	20			78	74	72	82	09	4
03	0	UNL	15			75	72	70	85	33	3
06	2	UNL	8			74	71	70	87	36	4
09	8	14	8			80	76	75	85	00	0
12	5	UNL	15			89	77	72	57	09	7
15	6	250	25			94	76	68	43	10	9
18	8	120	20			84	74	70	63	10	9
21	0	UNL	20			92	74	71	69	10	6
DAY 08											
00	1	UNL	20			79	74	72	79	14	5
03	*	9	12			77	74	73	88	00	0
06	5	UNL	8			75	74	73	94	00	0
09	4	UNL	15			85	77	74	70	09	8
12	3	UNL	20			91	76	69	49	07	8
15	8	250	25			97	77	69	39	07	14
18	6	250	20			95	75	66	39	09	10
21	9	UNL	20			88	70	60	39	10	10
DAY 09											
00	8	250	20			81	69	63	54	14	4
03	10	100	15			80	70	64	60	16	6
06	10	100	15			81	72	68	65	03	9
09	10	120	15			83	75	71	67	06	13
12	10	120	15			90	76	70	52	05	14
15	10	5	1	8	TRW	89	77	72	57	07	17
18	10	190	9			85	76	73	67	05	10
21	10	70	10			79	75	73	82	05	8
DAY 10											
00	10	100	15			81	75	72	74	03	9
03	10	24	10			81	75	72	74	04	12
06	10	22	7	R		78	75	74	84	04	14
09	10	19	4	R		77	75	74	91	03	17
12	10	80	5	R		76	75	74	94	03	17
15	10	30	5	R		76	74	73	90	05	22
18	10	28	5	R		76	74	73	90	07	20
21	10	20	6	R		76	72	70	82	06	17
DAY 11											
00	10	11	6		R	76	75	75	97	09	14
03	10	11	8		R	77	76	75	94	09	11
06	10	11	5		F	77	76	75	94	10	10
09	10	12	8		RW	78	76	75	91	09	14
12	10	28	10		RW	82	77	75	79	11	12
15	9	38	15			88	78	74	63	11	13
18	8	250	15			88	75	70	55	10	12
21	8	250	15			82	76	73	74	11	8
DAY 12											
00	10	10	10			77	76	75	94	10	4
03	10	8	8			77	76	76	97	10	6
06	9	8	7			77	76	76	97	10	6
09	9	30	15			82	76	74	77	10	11
12	7	30	25			87	77	73	63	14	8
15	9	UNL	25			92	77	71	50	13	10
18	9	UNL	25			89	76	71	55	14	9
21	6	UNL	25			84	77	74	72	14	7
DAY 13											
00	*	UNL	15			79	75	74	85	16	8
03	4	UNL	12			78	75	74	88	18	5
06	10	16	10			78	76	75	91	19	6
09	10	16	8			79	77	76	91	16	5
12	7	250	20			87	77	73	63	16	10
15	4	UNL	25			92	78	73	54	13	8
18	3	UNL	25			90	76	70	52	18	10
21	1	UNL	20			84	77	75	74	14	9
DAY 14											
00	0	UNL	20			79	76	75	88	16	8
03	0	UNL	12			78	74	73	85	16	8
06	0	11	12			81	75	73	77	16	8
09	0	UNL	12			87	76	72	61	21	11
12	0	UNL	20			93	77	71	49	13	10
15	0	UNL	25			93	77	71	49	19	12
18	0	UNL	25			97	79	73	46	12	12
21	0	UNL	20			86	77	74	68	13	10
DAY 15											
00	8	13	15			81	76	74	79	12	8
03	10	14	12			79	76	75	88	13	5
06	10	26	10			80	76	75	85	12	6
09	8	30	8			80	78	78	94	15	6
12	9	50	20			85	76	73	67	18	8
15	3	UNL	20			89	78	74	61	16	10
18	3	UNL	20			88	77	73	61	14	11
21	6	23	20			84	79	76	80	14	12
DAY 16											
00	10	14	15			80	77	76	88	14	11
03	9	13	12			79	76	75	88	16	11
06	10	14	10			77	76	75	94	16	8
09	8	24	12			80	76	75	85	16	11
12	6	30	15			87	78	74	65	17	11
15	7	34	15			90	78	73	57	16	12
18	8	250	15			84	78	76	77	12	14
21	9	16	12			80	78	77	91	13	12
DAY 17											
00	10	13	10			78	76	76	94	14	9
03	10	10	8			78	76	76	94	16	9
06	10	9	8			78	76	76	94	14	6
09	8	11	7			79	77	77	94	15	8
12	5	24	12			85	78	75	72	15	10
15	7	UNL	15			91	77	72	54	17	12
18	8	100	15			86	77	73	65	13	11
21	7	UNL	20			82	76	74	77	14	9
DAY 18											
00	10	11	10			78	75	74	88	15	9
03	10	8	8			77	76	75	94	14	11
06	9	11	8			77	76	75	94	16	10
09	6	16	8			81	77	76	85	16	11
12	7	30	12			86	77	74	68	16	12
15	5	UNL	15			90	75	69	50	15	13
18	2	UNL	15			89	76	70	54	14	11
21	0	UNL	15			83	74	70	65	13	10
DAY 19											
00	9	12	15			78	76	75	91	16	12
03	10	11	10			78	76	75	91	16	11
06	10	11	10			77	76	75	94	16	9
09	8	15	10			82	78	76	82	17	10
12	6	28	15			89	79	75	63	18	14
15	5	UNL	15			93	78	72	51	15	12
18	3	UNL	15			89	78	74	61	15	12
21	3	UNL	15			83	77	75	77	14	15
DAY 20											
00	10	11	10			78	75	74	88	17	10
03	7	10	10			76	75	74	94	17	8
06	8	19	10			75	74	74	97	16	7
09	7	17	10			79	74	72	79	16	10
12	3	UNL	12			84	75	71	65	20	7
15	2	UNL	15			90	75	68	48	16	10
18	1	UNL	20			89	74	68	50	14	9
21	0	UNL	15			84	74	70	63	13	8
DAY 21											
00	0	UNL	10			78	74	73	85	13	7
03	6	*	10			75	74	74	97	17	6
06	4	UNL	10			75	74	74	97	21	5
09	0	UNL	12			81	76	74	79	00	0
12	0	UNL	15			RW	74	70	55	16	5
15	0	UNL	15			92	76	69	47	19	8
18	0	UNL	15			90	76	70	52	18	7
21	0	UNL	20			85	74	69	59	18	6
DAY 22											
00	0	UNL	10			81	74	71	72	17	6
03	0	UNL	10			75	72	70	85	32	5
06	0	UNL	10			72	71	70	93	32	6
09	0	UNL	20			83	77	74	74	20	3
12	0	UNL	20			91	76	70	50	00	0
15	2	UNL	20			94	76	69	44	16	9
18	0	UNL	15			91	76	70	50	16	10
21	0	UNL	15			87	75	70	57	18	6
DAY 23											
00	0	UNL	15			84	75	71	65	17	7
03	0	UNL	15			77	73	71	82	31	5
06	0	UNL	15			73	70	69	87	34	4
09	0	UNL	10			83	77	74	74	00	0
12	0	UNL	15			91	77	70	47	07	9
15	0	UNL	15			94	77	70	46	09	8
18	0	UNL	15			91	76	70	50	17	7
21	0	UNL	15			87	76	72	61	18	4
DAY 24											
00	0	UNL	15			81	75	72	70	24	4
03	0	UNL	15			76	72	70	82	30	5
06	0	UNL	15			74	71	69	84	32	4
09	0	UNL	10			82	76	73	74	26	4
12	0	UNL	10			92	76	69	47	17	6
15	2	UNL	15			97	76	69	43	14	10
18	0	UNL	15			91	74	67	45	09	6
21	0	UNL	15			88	73	66	48	20	4
DAY 25											
00	2	UNL	15			79	72	68	69	01	4
03	0	UNL	15			75	70	68	79	32	5
06	0	UNL	15			73	70	69	87	01	3
09	0	UNL	8			81	75	73	77	14	4
12	3	UNL	12			91	76	70	50	14	4
15	3	UNL	10			93	77	70	47	12	7
18	3	UNL	10			85	75	71	63	15	8
21	0	UNL	12			83	73	69	63	12	9
DAY 26											
00	0	UNL	12			78	68	63	60	13	5
03	0	UNL	10			72	67	64	76	33	4
06	0	UNL	8			68	65	63	84	32	6
09	0	UNL	8			78	72	69	74	03	2
12	0	UNL	12			87	71	63	45	12	9
15	1	UNL	15			92	72	62	37	14	8
18	0	UNL	15			89	72	64	44	16	9
21	0	UNL	15			85	72	66	51	16	7
DAY 27											
00	8	UNL	12			80	75	73	79	14	7
03	0	UNL	12			76	73	72	87	10	4
06	3	UNL	7			73	72	71	91	15	*
09	1	UNL	6		H	79	75	73	82	06	3
12	1	UNL	8			87	75	70	57	14	3
15	4	UNL	10			91	75	69	47	12	8
18	4	UNL	15			88	74	67	50	13	7
21	2	UNL	12			82	74	70	67	12	7
DAY 28											
00	0	UNL	12			76	72	70	82	08	4
03	8	14	12			74	73	73	97	00	0
06	2	UNL	8			72	71	70	93	35	3
09	8	250	9			79	75	73	82	16	7
12	5	UNL	12			85	75	70	61	11	4
15	7	UNL	15			90	74	67	47	16	8
18	4	UNL	20			88	73	66	48	14	8
21	0	UNL	15			82	74	70	67	14	10
DAY 29											
00	0	UNL	20			79	75	74	85	14	4
03	10	11	10			76	75	74	94	13	4
06	7	9	8			76	75	74	94	18	5
09	6	14	15			81	76	74	79	18	7
12	4	UNL	15			87	76	72	61	24	6
15	4	UNL	15			92	75	68	45	12	6
18	3	UNL	20			83	74	70	65	14	10
21	4	14	10			79	74	72	79	12	8
DAY 30											
00	6	11	12			78	76	76	94	14	8
03	8	12	10			78	76	75	91	17	8
06	9	11	*			77	75	74	91	17	6
09	7	28	15			80	76	75	85	17	*
12	5	UNL	20			89	77	72	57	18	11
15	5	UNL	20			92	76	70	49	20	8
18	2	UNL	20			89	76	71	57	16	15
21	0	UNL	20			82	74	70	67	13	10
DAY 31											
00	10	13	15			78	76	75	91	13	10
03	6	12	12			78	76	75	91	16	8
06	10	10	9			77	76	75	94	16	10
09	5	UNL	15			80	75	73	73	16	14
12	6	35	15			88	77	72	59	16	13
15	5	UNL	20			93	76	69	46	16	14
18	0	UNL	20			84	76	73	70	17	11
21	2	UNL	15			81	76	74	79	13	8

STATION

SAN ANTONIO TEXAS

YEAR & MONTH

80 OH

NOTES

CEILING
UNL INDICATES UNLIMITED

WEATHER

+	TORNADO
T	THUNDERSTORM
Q	SQUALL
R	RAIN
RW	RAIN SHOWERS
ZR	FREEZING RAIN
L	DRIZZLE
ZL	FREEZING DRIZZLE
S	SNOW
SP	SNOW PELLETS
IC	ICE CRYSTALS
SW	SNOW SHOWERS
SG	SNOW GRAINS
IP	ICE PELLETS
A	HAIL
F	FOG
IF	ICE FOG
GF	GROUND FOG
BD	BLOWING DUST
BN	BLOWING SAND
BS	BLOWING SNOW
BT	BLOWING SPRAT
K	SMOKE
H	HAZE
D	DUST

WIND

DIRECTIONS ARE THOSE FROM WHICH THE WIND BLOWS, INDICATED IN TENS OF DEGREES FROM TRUE NORTH: I.E., 09 FOR EAST, 18 FOR SOUTH, 27 FOR WEST. ENTRY OF 00 IN THE DIRECTION COLUMN INDICATES CALM.

SPEED IS EXPRESSED IN KNOTS; MULTIPLY BY 1.15 TO CONVERT TO MILES PER HOUR.

U.S. DEPARTMENT OF COMMERCE
NATIONAL CLIMATIC CENTER
FEDERAL BUILDING
ASHEVILLE, N.C. 28801

LCD-41-12921-FR

STATE DEPT OF HIGHWAYS & PUBLIC TRANS.
ATTN: JOHN F NIXON
ENGINEER OF RESEARCH
P O BOX 5051
AUSTIN, TX 78763

APPENDIX H

12554

AIR POLLUTION SAMPLE REPORT

Name of Property Sampled: Sulflex Paving Experimental Study Address: North Loop -- FM 1604

City: San Antonio County: Bexar Region: 9 Type of Industry: hot mix mfg.

Name and Title of Party Contacted at Property: McDonough Bros., Inc; Roger Hopper, Supt.

****

Sampled By: San Antonio Metropolitan Hea. Dept. Plant Status: paving machine -- in operation

Remarks: samples taken to determine levels of emission of H_2S and SO_2 due to paving operation

****

Please analyze as checked below. Date: 8-28-80 Requested By: Manny Pointer

Included: SO_2 runs -- 2 samples; 2 SO_2 absorber blanks; 2 DI H_2O blanks

H_2S runs -- 2 samples; 2 blanks of H_2S absorber

SAMPLE IDENTITY						LABORATORY ANALYSIS			
Date Collected / Field Number	Sampling Equipment	TIME Start / End / Total Min.	SAMPLE Rate(cfm) / Total Vol(M^3)	WIND Direction / Speed(mph)	NUMBER ACL Number	Susp. Part. ($\mu g/M^3$)			
8-26-80	telematic	1020 A / 1050 A / 30	2.8 liters/min / 84 liters		2381		SO_2 sample	1659 $\mu g/M^3$ .622 ppm	
	#3546								
8-26-80	telematic	1125 A / 1155 A / 30	2.8 liters/min / 84 liters				SO_2 sample	56.9 $\mu g/M^3$ .021 ppm	
	#3546								
8-26-80	telematic	1020 A / 1050A / 30	2.8 liters/min / 84 liters/min				H_2S sample	5150 $\mu g/M^3$ 3.64 ppm	
	#3543								
8-26-80	telematic	1125 A / 1155A / 30	2.7 liters/min / 81 liters				H_2S sample	1.110 $\mu g/M^3$ .0008 ppm	
	#3543								

Remarks: Samples 1 & 3 taken within 2' downwind of paving machine. Samples 2 & 4 taken 200' downwind of paving machine. Gravimetrical Analysis: _____

Date Received: August 28, 1980 Date Reported: September 9, 1980 Chemical Analysis: Margaret J. Zimmerman

H-1

TEXAS AIR CONTROL BOARD
LABORATORY
6330 Highway 290 East
Austin, Texas 78723

Sample: Sulfex Paving
McDonough Bros,
San Antonio, Tx.

ACL Number: 2381

Delivered By: Manny Pointer, Evaluation Source

Description:

Date Sampled: August 26, 1980

LABORATORY ANALYSIS

	Impinger #	Soluenol	Vinyl Toluene	Dicyclopeatadiene
	1	N.D.*	94 ppb by Vol.	1129 ppm by Vol.
	2	N.D.	4 ppb by Vol.	183 ppm by Vol.
Sample	1	N.D.	86 ppb by Vol	Sample broken
Sample	2	N.D.	0.5 ppb by Vol.	Sample Broken

*N.D. = none detected

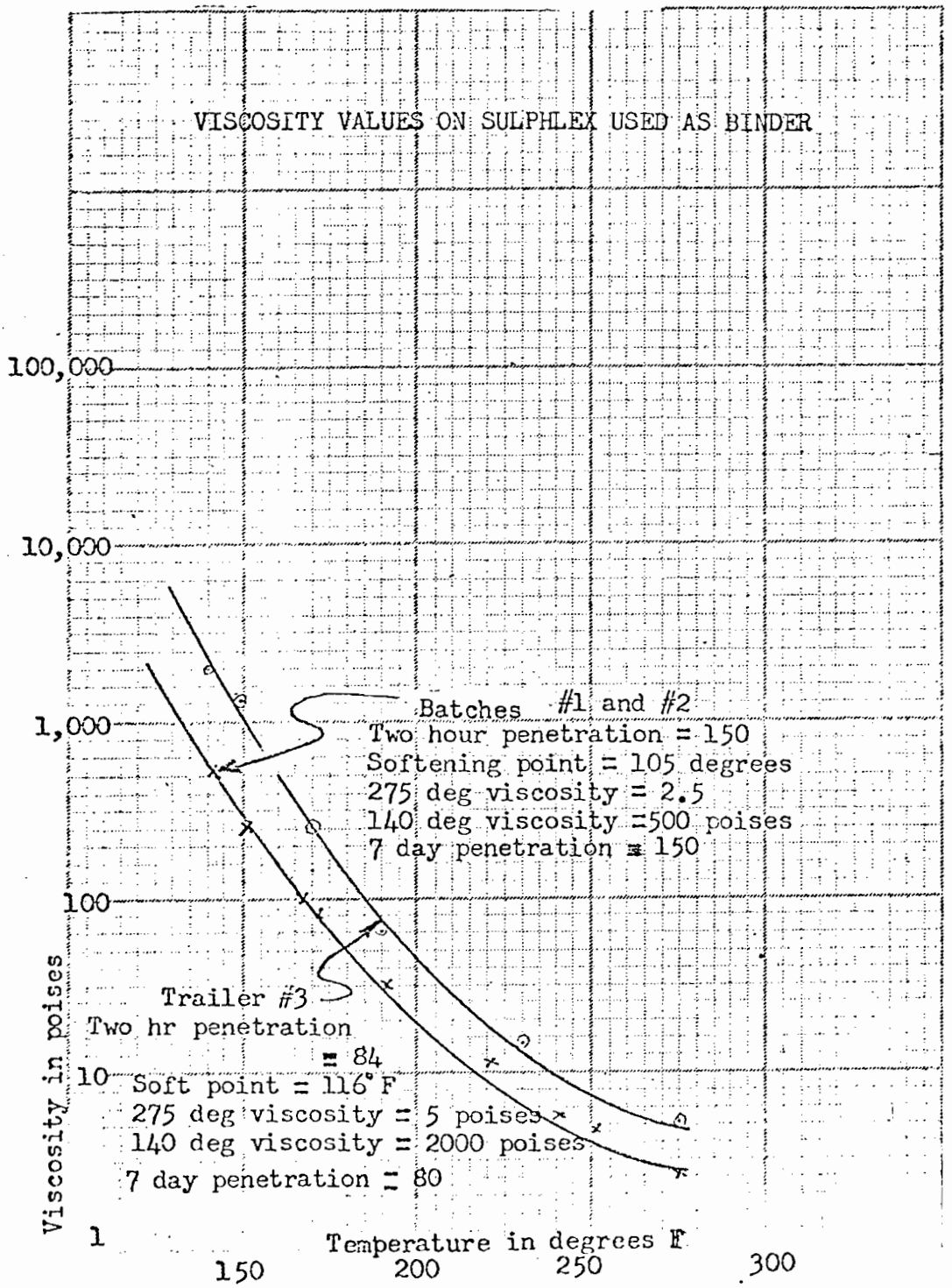
August 28, 1980
Date Received

November 13, 1980
Date Reported

Henry J. Krauss
Analysis Performed By

Henry J. Krauss

APPENDIX I



(Courtesy of Southwest Research Institute)

APPENDIX J

Initial Visual Aug 12, 1980

Figure 1. Maintenance Rating Form for Flexible Pavements

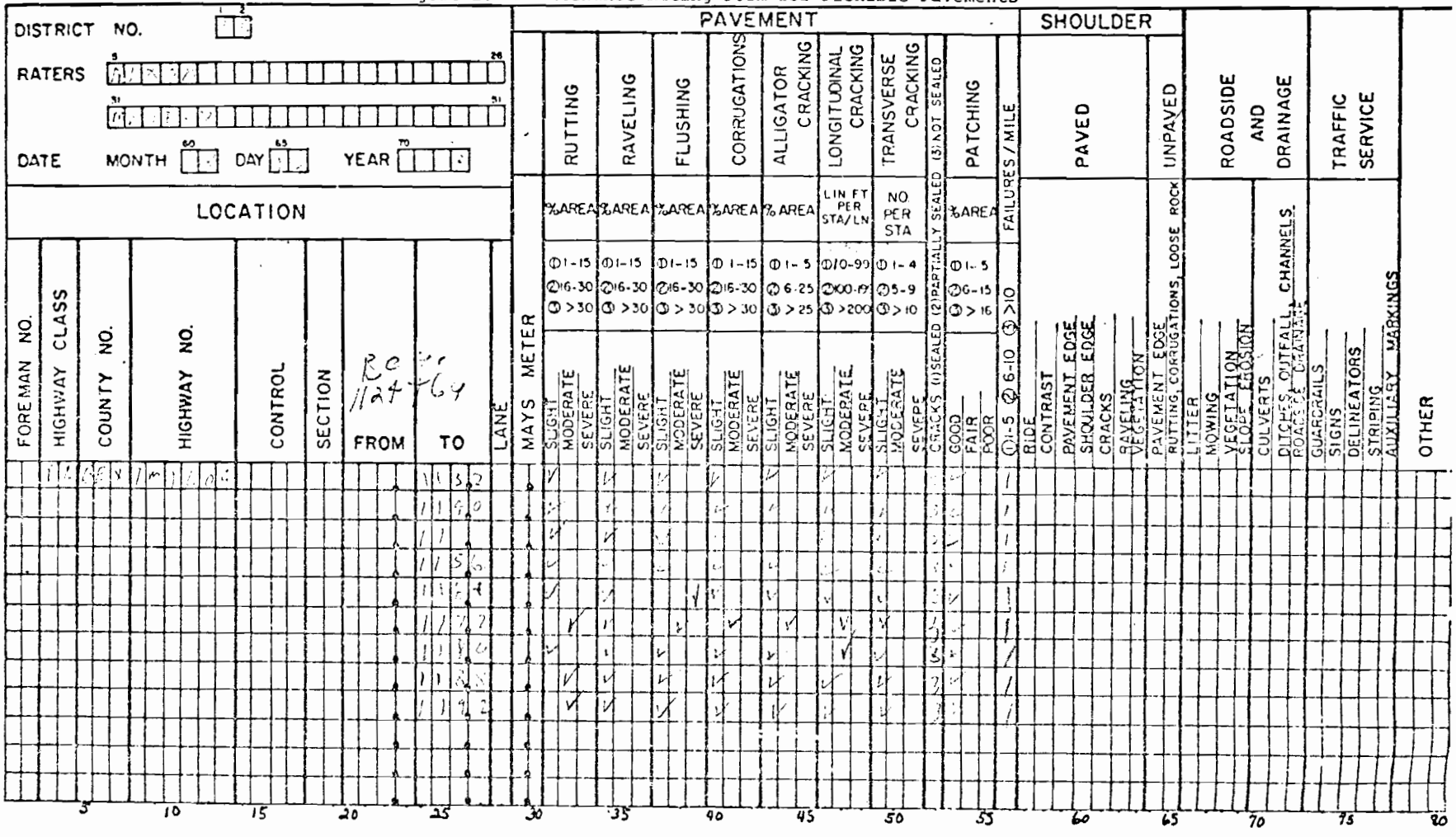


Figure 1. Maintenance Rating Form for Flexible Pavements

DISTRICT NO. (1–2)

RATERS (3–28, 31–51)

DATE: MONTH (60) DAY (65) YEAR (70)

LOCATION: FOREMAN NO. | HIGHWAY CLASS | COUNTY NO. | HIGHWAY NO. | CONTROL | SECTION | FROM | TO | LANE

PAVEMENT

MAYS METER

Item	Measure	Ranges	Levels
RUTTING	% AREA	① 1-15 ② 15-30 ③ > 30	SLIGHT / MODERATE / SEVERE
RAVELING	% AREA	① 1-15 ② 16-30 ③ > 30	SLIGHT / MODERATE / SEVERE
FLUSHING	% AREA	① 1-15 ② 16-30 ③ > 30	SLIGHT / MODERATE / SEVERE
CORRUGATIONS	% AREA	① 1-15 ② 16-30 ③ > 30	SLIGHT / MODERATE / SEVERE
ALLIGATOR CRACKING	% AREA	① 1-5 ② 6-25 ③ > 25	SLIGHT / MODERATE / SEVERE
LONGITUDINAL CRACKING	LIN FT PER STA/LN	① 10-99 ② 100-199 ③ > 200	SLIGHT / MODERATE / SEVERE
TRANSVERSE CRACKING	NO PER STA	① 1-4 ② 5-9 ③ > 10	SLIGHT / MODERATE / SEVERE
CRACKS		(1) SEALED (2) PARTIALLY SEALED (3) NOT SEALED	
PATCHING	% AREA	① 1-5 ② 6-15 ③ > 16	GOOD / FAIR / POOR
FAILURES / MILE		① 1-5 ② 6-10 ③ > 10	

SHOULDER

PAVED: RIDE; CONTRAST; PAVEMENT EDGE; SHOULDER EDGE; CRACKS; RAVELING; VEGETATION

UNPAVED: PAVEMENT EDGE; RUTTING, CORRUGATIONS, LOOSE ROCK

ROADSIDE AND DRAINAGE: LITTER; MOWING; VEGETATION; SLOPE EROSION; CULVERTS; DITCHES, OUTFALL, CHANNELS; ROADSIDE DRAINAGE

TRAFFIC SERVICE: GUARDRAILS; SIGNS; DELINEATORS; STRIPING; AUXILIARY MARKINGS

OTHER

Handwritten location entries:

Highway No. / Control (From–To)	From	To
0 to .15	122	123
.15 to .3		123
.3 to .45		
.45 to .60		
.60 to .75		
.75 to .90		
.90 to 1.05		
1.20		
1.35		
1.50		

Card columns: 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80

APPENDIX K

STATE DEPARTMENT OF
HIGHWAYS AND PUBLIC TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
AUSTIN, TEXAS 78703

PAGE

MCS.TST.14 ASPHALTIC CONCRETE STABILITY REPORT D-9 CHARGES 33.75

CONTRACT NO. REQ NO. CONTROL - - 0000
ENGINEER R.H. MAGERS PROJECT 30-3-24015-807
CONTRACTOR DIST 49 CO HWY

LABORATORY NO. H80405196 DATE RECD 08/29/80 DATE REPTD 09/02/80
DATE SAMPLED 08/26/80
MATERIAL Sulphlex 233A CODE 0000000000
PRODUCER CODE 000
IDENTIFICATION MARKS SPEC. ITEM 0340
SAMPLED FROM TRUCK QUANTITY UNIT

SAMPLE NUMBER	SPEC. NO.	IDENT. MARKS	COHESIOMETER VALUE (AVG.)	ASPHALT (% BY WT.)	SPEC. HT. (IN.)	SPEC.DENS. FIELD (AVG. %)	HVEEM STABILI (%)	(AVG.%
13	1				2.02		48	
	2			7.0	2.05	96.5	49	48
	3				2.05		48	
14	1				2.05		50	
	2			7.5	2.06	96.9	46	48
	3				2.06		47	
15	1				2.02		48	
	2			8.0	2.02	98.1	47	47
	3				2.02		47	

HVEEM STABILITY
AND/OR COHESIOMETER
VALUES
MEET SPECIFICATION

DIVISION OF MATERIALS AND TESTS

SEP - 8 1980

ENGINEER OF MATERIALS AND TESTS

STATE DEPARTMENT OF
HIGHWAYS AND PUBLIC TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
AUSTIN, TEXAS 78703

PAGE

MCS.TST.14 ASPHALTIC CONCRETE STABILITY REPORT C-9 CHARGES 22.50

CONTRACT NO. REC NO. CONTROL - - 0000
ENGINEER R. H. MAGERS PROJECT 30-3-0240-054-415
CONTRACTOR DIST 49 CO HWY

LABORATORY NO. H80405164 DATE RECD 08/28/80 DATE REPTD 08/29/80
DATE SAMPLED 09/25/80
MATERIAL TY. D (AC-20) CODE 0000000000
PRODUCER CODE 000
IDENTIFICATION MARKS SPEC. ITEM 0340
SAMPLED FROM TRUCK QUANTITY UNIT

SAMPLE NUMBER	SPEC. NO.	IDENT. MARKS	COHESIOMETER VALUE (AVG.)	ASPHALT (% BY WT.)	SPEC. HT. (IN.)	SPEC.DENS. FIELD (AVG. %)	HVEEM STABILI (%)	(AVG.S
07	1				2.04		51	
	2			4.7	2.04	94.2	51	50
	3				2.04		47	
08	1	4			2.02		49	
	2	5		4.7	2.03	95.4	47	48
	3	6			2.03		48	

****
* HVEEM STABILITY *
* AND/OR COHESIOMETER *
* VALUES *
* MEET SPECIFICATION *
****

****
* DIVISION OF MATERIALS AND TESTS *
*
*
*
* ENGINEER OF MATERIALS AND TESTS *
****

APPENDIX L

TEXAS HIGHWAY DEPARTMENT

DISTRICT 15 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 07-10-80

****

PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		FM1604	02-06-80	29

REASONS FOR MEASUREMENTS AND COMMENTS
EX - SULFLEX TEST SECTION

TOTAL PAV DEPTH
9.00 INCHES

****

EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
ASPH.CONC.PVMT.	1.00
FLEX.BASE-RDWY.CUT	8.00
SUBGR.SOILS	0.0

****

GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NORTH WITH MILEPOINTS
MEASUREMENTS ARE 04 FEET FROM THE RIGHT SIDE OF LANE A

DESCRIPTION OF LOCATION ODOMETER READING MILEPOINT
FROM-JCT. SH16
TO- JCT. WHITE FAWN RD.

****

PLOTS WERE REQUESTED WITH THIS PROGRAM.

****

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		FM1604	02-06-80	29

DYNAFLECT DATA

ODOMETER	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
0.00	0.500	0.310	0.210	0.126	0.093	0.190	0.33	0.59	STRUCTURE SH 16
0.20	0.900	0.600	0.290	0.200	0.099	0.300	0.28	0.64	FILL
0.40	0.570	0.400	0.250	0.129	0.084	0.170	0.30	0.72	
0.60	0.740	0.420	0.330	0.111	0.069	0.320	0.32	0.51	
0.80	0.530	0.300	0.111	0.060	0.040	0.230	0.35	0.53	PATCHED PVMT.
1.00	0.230	0.084	0.047	0.042	0.040	0.146	0.52	0.47	
1.20	0.930	0.600	0.270	0.141	0.084	0.330	0.29	0.60	INTER.HAUSMAN F
1.40	0.670	0.420	0.240	0.129	0.066	0.250	0.31	0.59	
1.60	0.720	0.380	0.135	0.069	0.035	0.340	0.34	0.47	SEALED PATCHES
1.80	0.690	0.430	0.230	0.099	0.060	0.260	0.31	0.58	NUMEROUS CRACK
2.00	0.840	0.330	0.120	0.066	0.047	0.510	0.37	0.36	SEALED PATCHES
2.20	0.560	0.270	0.081	0.043	0.032	0.290	0.37	0.44	
2.40	0.440	0.200	0.060	0.042	0.031	0.240	0.40	0.44	
2.60	0.300	0.093	0.040	0.032	0.028	0.207	0.54	0.41	DOWN GRADE
AVERAGES	0.616	0.345	0.172	0.092	0.058	0.270	0.36	0.52	
STANDARD DEVIATION						0.091	0.08	0.10	

NUMBER OF POINTS IN AVERAGE = 14

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 15 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 07-10-80

****

PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		FM1604	02-06-80	29

REASONS FOR MEASUREMENTS AND COMMENTS
EX - SULFLEX TEST SECTION

TOTAL PAV DEPTH
9.00 INCHES

****

EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
ASPH.CONC.PVMT.	1.00
FLEX.BASE-RDWY.CUT	8.00
SUBGR.SOILS	0.0

****

GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS SOUTH OPPOSITE MILEPOINTS
MEASUREMENTS ARE 04 FEET FROM THE RIGHT SIDE OF LANE A

DESCRIPTION OF LOCATION ODOMETER READING MILEPOINT

FROM-JCT.WHITE FAWN ROAD
TO- JCT.SH16

****

PLOTS WERE REQUESTED WITH THIS PROGRAM.

****

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		FM1604	02-06-80	29

DYNAFLECT DATA

ODOMETER	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
0.00	0.520	0.320	0.081	0.034	0.022	0.200	0.33	0.59	150FT.S.WHITE F
0.20	0.540	0.230	0.030	0.025	0.021	0.310	0.40	0.41	UP GRADE
0.40	0.440	0.200	0.043	0.030	0.022	0.240	0.40	0.44	
0.60	0.930	0.870	0.780	0.600	0.023	0.060	0.19	1.84	FILL-ON CULVER
0.80	0.250	0.093	0.040	0.029	0.022	0.157	0.50	0.46	
1.00	0.990	0.750	0.600	0.093	0.060	0.240	0.25	0.83	PATCHED PVMT.
1.20	0.780	0.350	0.135	0.060	0.040	0.430	0.36	0.39	SHOULDER CRACK
1.40	0.900	0.720	0.600	0.035	0.027	0.180	0.24	0.96	300' N HAUSMAN
1.60	0.260	0.090	0.040	0.035	0.027	0.170	0.52	0.44	
1.80	0.620	0.350	0.220	0.050	0.032	0.270	0.34	0.51	DOWN GRADE
2.00	0.900	0.720	0.600	0.030	0.025	0.180	0.24	0.96	PATCHED PVMT.
2.20	1.440	1.020	0.780	0.660	0.147	0.420	0.24	0.71	
2.40	0.930	0.690	0.340	0.220	0.111	0.240	0.26	0.79	SLIGHT FILL
2.60	0.930	0.720	0.400	0.300	0.250	0.210	0.25	0.88	
2.70	0.960	0.600	0.220	0.135	0.102	0.360	0.29	0.57	RAMP TO SH 16
AVERAGES	0.759	0.515	0.327	0.156	0.062	0.244	0.32	0.72	
STANDARD DEVIATION						0.101	0.10	0.37	

NUMBER OF POINTS IN AVERAGE = 15

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 15 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 05-12-81

****

PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-04-80	29

REASONS FOR MEASUPEMENTS AND COMMENTS — TOTAL PAV DEPTH

EX - TY D CONTROL MIX — 10.00 INCHES

****

EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
TY D CONTROL MIX	1.00
TYPE D HMACP	1.00
FLEX BASE	0.08
SUBGR.SOILS	0.0

****

GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NO. EAST OPPOSITE MILEPOINTS
MEASUREMENTS ARE 03 FEET FROM THE RIGHT SIDE OF LANE A

DESCRIPTION OF LOCATION — ODOMETER READING — MILEPOINT

FROM-STATION 1204+06
TO-STATION 1160+00

****

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-04-80	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
1203+00	0.480	0.330	0.159	0.105	0.060	0.150	0.31	0.65	
1201+00	0.255	0.114	0.050	0.042	0.035	0.141	0.45	0.49	
1199+00	0.237	0.096	0.046	0.039	0.038	0.141	0.48	0.48	
1197+00	0.370	0.260	0.102	0.050	0.041	0.110	0.33	0.69	INT. FM 1560
1195+00	0.770	0.550	0.320	0.126	0.063	0.220	0.28	0.68	
1193+00	0.770	0.560	0.290	0.096	0.052	0.210	0.27	0.70	
1191+00	0.750	0.450	0.165	0.052	0.044	0.300	0.31	0.52	
1189+00	0.480	0.300	0.087	0.045	0.040	0.180	0.33	0.57	
1187+00	0.540	0.340	0.129	0.045	0.041	0.200	0.32	0.57	
1185+00	0.700	0.500	0.270	0.105	0.069	0.200	0.28	0.68	
1183+00	1.200	0.900	0.430	0.210	0.120	0.300	0.24	0.74	
1181+00	0.550	0.320	0.102	0.062	0.050	0.230	0.34	0.52	
1179+00	0.710	0.450	0.165	0.081	0.045	0.260	0.30	0.56	
1177+00	0.690	0.410	0.250	0.120	0.063	0.280	0.32	0.51	
1175+00	0.600	0.360	0.126	0.120	0.039	0.240	0.33	0.53	
1173+00	0.410	0.250	0.080	0.053	0.042	0.160	0.35	0.57	
1171+00	0.700	0.470	0.260	0.135	0.093	0.230	0.30	0.61	
1169+00	1.170	0.720	0.330	0.105	0.040	0.450	0.28	0.51	
1167+00	0.680	0.390	0.138	0.060	0.040	0.290	0.32	0.49	
1165+00	0.670	0.430	0.174	0.072	0.045	0.240	0.31	0.57	
1163+00	0.930	0.710	0.410	0.240	0.111	0.220	0.25	0.77	
1161+00	1.110	0.750	0.390	0.220	0.099	0.360	0.27	0.60	
AVERAGES	0.671	0.439	0.203	0.099	0.058	0.232	0.32	0.59	
STANDARD DEVIATION						0.078	0.06	0.09	

NUMBER OF POINTS IN AVERAGE = 22

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 15 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 05-12-81

****

PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-04-80	29

REASONS FOR MEASUREMENTS AND COMMENTS — TOTAL PAV DEPTH

EX - 8.0P SULPHLEX SECTION — 10.00 INCHES

****

EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
SULPHLEX 8.0P	1.00
TYPE D HMACP	1.00
FLEX BASE	8.00
SUBGR.SOILS	0.0

****

GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NO. EAST OPPOSITE MILEPOINTS

MEASUREMENTS ARE 03 FEET FROM THE RIGHT SIDE OF LANE A

DESCRIPTION OF LOCATION — ODOMETER READING — MILEPOINT

FROM-STATION 1160+00

TO-STATION 1124+69

****

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-04-80	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
1159+00	0.570	0.370	0.177	0.114	0.087	0.200	0.31	0.59	
1157+00	0.420	0.144	0.042	0.036	0.032	0.276	0.47	0.40	
1155+00	0.570	0.340	0.147	0.090	0.066	0.230	0.33	0.53	
1153+00	0.630	0.380	0.126	0.060	0.038	0.250	0.32	0.53	
1151+00	1.230	0.900	0.460	0.300	0.220	0.330	0.25	0.70	
1149+00	0.560	0.400	0.230	0.120	0.078	0.160	0.30	0.69	
1147+00	0.440	0.280	0.120	0.078	0.046	0.160	0.34	0.59	
1145+00	0.730	0.460	0.230	0.090	0.046	0.270	0.30	0.55	
1143+00	0.490	0.320	0.090	0.036	0.032	0.170	0.32	0.61	
1141+00	0.480	0.290	0.084	0.034	0.032	0.190	0.34	0.55	
1139+00	0.640	0.420	0.150	0.069	0.035	0.220	0.31	0.59	
1137+00	0.540	0.340	0.111	0.050	0.034	0.200	0.32	0.57	
1135+00	0.350	0.200	0.180	0.040	0.032	0.150	0.37	0.54	
1133+00	0.410	0.250	0.048	0.035	0.032	0.160	0.35	0.57	
1131+00	0.400	0.240	0.078	0.046	0.036	0.160	0.35	0.56	
1129+00	0.340	0.220	0.075	0.048	0.038	0.120	0.35	0.62	
1127+00	0.330	0.230	0.108	0.045	0.035	0.100	0.34	0.69	
1125+00	0.310	0.200	0.078	0.045	0.030	0.110	0.36	0.63	
AVERAGES	0.524	0.332	0.141	0.074	0.053	0.192	0.34	0.58	
STANDARD DEVIATION						0.062	0.04	0.07	

NUMBER OF POINTS IN AVERAGE = 18

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 15 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 05-12-81

****

PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-03-80	29

REASONS FOR MEASUREMENTS AND COMMENTS — TOTAL PAV. DEPTH

EX - TY D CONTROL MIX SEC. — 10.00 INCHES

****

EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
TY D CONTROL MIX	1.00
TY D HMACP	1.00
FLEX BASE	8.00
SUBGR.SOILS	0.0

****

GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS SO. WEST WITH MILEPOINTS
MEASUREMENTS ARE 03 FEET FROM THE RIGHT SIDE OF LANE A

DESCRIPTION OF LOCATION — ODOMETER READING — MILEPOINT

FROM-STATION 1124+69
TO-STATION 1164+70

****

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-03-80	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
1125+00	0.440	0.260	0.138	0.075	0.044	0.180	0.35	0.54	
1127+00	0.640	0.320	0.084	0.022	0.020	0.320	0.35	0.44	CUT
1129+00	0.520	0.270	0.084	0.035	0.023	0.250	0.36	0.47	CUT
1131+00	0.460	0.260	0.108	0.066	0.030	0.200	0.35	0.52	CUT
1133+00	0.264	0.075	0.030	0.020	0.016	0.189	0.62	0.42	
1135+00	0.360	0.200	0.056	0.040	0.035	0.160	0.38	0.53	
1137+00	0.165	0.072	0.035	0.030	0.028	0.093	0.51	0.53	
1139+00	0.560	0.300	0.114	0.020	0.038	0.260	0.35	0.48	
1141+00	0.540	0.300	0.081	0.040	0.032	0.240	0.35	0.50	
1143+00	0.620	0.360	0.126	0.055	0.040	0.260	0.33	0.51	
1145+00	0.700	0.420	0.200	0.075	0.040	0.280	0.31	0.52	SL.FILL
1147+00	0.750	0.500	0.280	0.126	0.024	0.250	0.29	0.60	
1149+00	0.520	0.360	0.240	0.120	0.066	0.160	0.31	0.66	6FT.FILL
1151+00	0.860	0.660	0.440	0.280	0.200	0.220	0.26	0.74	
1153+00	0.900	0.500	0.200	0.050	0.035	0.400	0.31	0.46	2FT.FILL
1155+00	0.360	0.045	0.060	0.040	0.036	0.315	3.39	0.37	SL ROCKY CUT
1157+00	0.320	0.060	0.042	0.038	0.032	0.260	1.72	0.38	
1159+00	0.700	0.420	0.240	0.129	0.102	0.280	0.31	0.52	
1161+00	0.850	0.660	0.420	0.026	0.132	0.190	0.25	0.81	GRADE
1163+00	1.050	0.810	0.400	0.250	0.114	0.240	0.24	0.79	SL.FILL
AVERAGES	0.580	0.343	0.169	0.077	0.054	0.237	0.57	0.54	
STANDARD DEVIATION						0.068	0.74	0.12	

NUMBER OF POINTS IN AVERAGE = 20

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 15 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 05-12-81

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PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-03-80	29

REASONS FOR MEASUREMENTS AND COMMENTS — TOTAL PAV DEPTH

EX - 7.0P SULPHLEX SECTION — 10.00 INCHES

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EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
SULPHLEX 7.0P	1.00
TYPE D HMACP	1.00
FLEX BASE	8.00
SUBGR.SOILS	0.0

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GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS SO. WEST WITH MILEPOINTS INCREASING

MEASUREMENTS ARE 03 FEET FROM THE RIGHT SIDE OF LANE A

DESCRIPTION OF LOCATION	ODOMETER READING	MILEPOINT
FROM-STATION 1164+70		
TO-STATION 1195+00		

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DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-03-80	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
1165+00	0.540	0.360	0.200	0.072	0.135	0.180	0.31	0.62	
1167+00	0.840	0.540	0.270	0.090	0.040	0.300	0.29	0.56	SL.FILL
1169+00	0.910	0.620	0.320	0.135	0.060	0.290	0.28	0.61	SL.FILL
1171+00	0.730	0.480	0.320	0.144	0.090	0.250	0.30	0.59	SL.FILL
1173+00	0.420	0.220	0.066	0.132	0.120	0.200	0.38	0.49	CULVERT
1175+00	0.770	0.400	0.114	0.050	0.040	0.370	0.33	0.44	SL.CUT
1177+00	0.750	0.430	0.147	0.060	0.045	0.320	0.32	0.49	
1179+00	0.560	0.340	0.132	0.054	0.045	0.220	0.33	0.54	
1181+00	0.780	0.480	0.230	0.096	0.060	0.300	0.30	0.53	
1183+00	1.200	0.840	0.390	0.230	0.117	0.360	0.26	0.64	
AVERAGES	0.750	0.471	0.219	0.106	0.075	0.279	0.31	0.55	
STANDARD DEVIATION						0.065	0.03	0.06	

NUMBER OF POINTS IN AVERAGE = 10

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 15 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 05-12-81

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PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-03-80	29

REASONS FOR MEASUREMENTS AND COMMENTS — TOTAL PAV. DEPTH

EX - 7.5P SULPHLEX SECTION — 10.00 INCHES

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EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
SULPHLEX 7.5P	1.00
TYPE D HMACP	1.00
FLEX BASE	8.00
SUBGR SOILS	0.0

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GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS SO. WEST WITH MILEPOINTS INCREASING

MEASUREMENTS ARE 03 FEET FROM THE RIGHT SIDE OF LANE A

DESCRIPTION OF LOCATION	ODOMETER READING	MILEPOINT
FROM-STATION 1185+00		
TO-STATION 1192+33		

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DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-03-80	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
1185+00	1.080	0.720	0.280	0.096	0.045	0.360	0.27	0.58	
1187+00	0.760	0.440	0.108	0.045	0.035	0.320	0.32	0.49	
1189+00	0.720	0.460	0.200	0.050	0.045	0.260	0.30	0.56	
1191+00	0.780	0.400	0.045	0.040	0.032	0.380	0.33	0.43	
AVERAGES	0.835	0.505	0.158	0.058	0.039	0.330	0.31	0.52	
STANDARD DEVIATION						0.053	0.03	0.07	

NUMBER OF POINTS IN AVERAGE = 4

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 15 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 05-12-81

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PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-04-80	29

REASONS FOR MEASUREMENTS AND COMMENTS — TOTAL PAV DEPTH

EX - 8.0P SULPHLEX SECTION — 10.00 INCHES

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EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
SULPHLEX 8.0P	1.00
TYPE D HMACP	1.00
FLEX BASE	8.00
SUBGR.SOILS	0.0

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GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS SO. WEST WITH MILEPOINTS.
MEASUREMENTS ARE 03 FEET FROM THE RIGHT SIDE OF LANE A

DESCRIPTION OF LOCATION — ODOMETER READING — MILEPOINT

FROM-STATION 1192+33
TO-STATION 1204+06

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DIST.	COUNTY	CONT.	SECT.	RPSN	HIGHWAY	DATE	DYNAFLECT
15	BEXAR	2452	01		LP 1604	09-04-90	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
1193+00	0.890	0.700	0.032	0.030	0.022	0.190	0.25	0.83	
1195+00	0.810	0.640	0.030	0.025	0.020	0.170	0.25	0.84	
1197+00	0.440	0.280	0.102	0.025	0.021	0.160	0.34	0.59	INT. FM 1560
1199+00	0.240	0.132	0.038	0.028	0.022	0.108	0.41	0.56	
1201+00	0.320	0.210	0.069	0.028	0.024	0.110	0.35	0.64	
1203+00	0.820	0.620	0.440	0.250	0.135	0.200	0.26	0.76	
AVERAGES	0.587	0.430	0.118	0.064	0.041	0.156	0.31	0.70	
STANDARD DEVIATION						0.039	0.07	0.12	

NUMBER OF POINTS IN AVERAGE = 6

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT