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Current Practices on Nighttime Pavement Construction—Asphaltic Concrete

W. P. Wills

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Final Report

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16. Abstract <p>The magnitude of scheduled airline operations at civil airports has made it imperative that runway repair and overlay with hot mix asphaltic concrete be accomplished at night so as not to interfere with normal airline flight schedules.</p> <p>Technical data and recommended construction practices such as working hours, construction lighting, automatic grade control, standby equipment, compaction, milling, stress absorbing membrane, sawing joints in overlay, construction of transition and other related items are discussed in this study.</p> <p>*The practices involving repair of existing pavements and construction of high quality overlays using asphaltic concrete are entirely possible during nighttime.</p> <p>*See third paragraph under "General" of Section 2 for explanation of asterisk.</p>					
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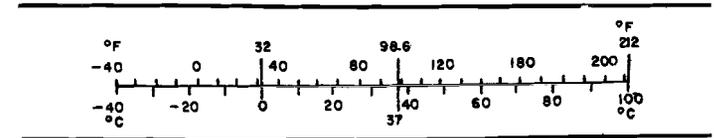
METRIC CONVERSION FACTORS

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	6	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



*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price \$2.25, SD Catalog No. C13.10:286.

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SECTION 1

INTRODUCTION

BACKGROUND

The magnitude of scheduled airline operations at major civil airports has made it imperative that runway repair and overlay with hot mix asphaltic concrete be accomplished in such manner as not to substantially interfere with normal airline flight schedules.

Even though the civil airport might have a parallel runway facility, the number of scheduled aircraft operations will deem it mandatory that both runways be made available for aircraft operations in the daytime in order for the airlines to maintain their flight schedules for the convenience of the traveling public. Any major airport that has enough aircraft traffic to warrant a parallel runway cannot maintain their operational capabilities with one parallel runway closed in order to allow for daytime construction. Therefore, the best means to accomplish this purpose is for the airport authority to require nighttime construction. By this method the runway is closed at night for a pre-determined period and during this closure period, aircraft will use other runway facilities or suspend operations altogether for both air carrier and general civil aviation. In any event, a serious and favorable consideration should be given at all times to perform the entire work at night to prevent closing of the runway during peak daytime travel periods for repair and overlay with hot mix asphaltic concrete pavement.

OBJECTIVE

The objective of this study is to determine what nighttime construction practices with asphaltic concrete will result in satisfactorily constructed pavements for civil airports. This study is confined to construction practices, procedures, and criteria that will apply to repair and overlay projects which will allow the maximum amount of hot mix asphaltic concrete pavement to be effectively placed each night.

SCOPE

In general, this study is a review of the past experience and practices in nighttime pavement construction practiced at selected civil airports. This study is concerned with the current practices involved with asphaltic concrete paving that permits normal aircraft traffic after each night's construction operation. Conclusions and recommendations are based on the construction procedures followed at the selected civil airports as well as the experiences of the author and other experts on overlay of runways at military airfields and civil airports where nighttime construction procedures were followed. The report includes a sample set of plans which illustrate the drawings necessary to furnish the contractor sufficient information to construct the hot mix asphaltic concrete overlay portion of the project. Sample drawings for "in runway" light adjustments and markings are not included.

SECTION 2

TECHNICAL DATA

General

A study of nighttime pavement construction practices with asphaltic concrete was previously conducted. The study involved gathering of information on nighttime construction practices and procedures used at various airports. A summary of information from seven airports was obtained and reported. The information was used to develop a logical set of practices with workable procedures. Experiences of the author and contractors experienced in nighttime paving were included in the development. Results of the study with the recommended practices were reported in Report No. FAA-RD-76-221, "Study of Night-time Pavement Construction Practices-Asphaltic Concrete," dated December 1976.

Since the RD-76-221 report, some additional practices which were being used in daytime construction were apparently being introduced in nighttime asphaltic concrete overlay projects. Some of the additional practices are: (1) replacing failed slabs with precast concrete panels, (2) cold milling to level up and properly grade existing surfaces, (3) using fabric, heater scarifying, or rubber-asphalt surface treatments for retardation or prevention of crack reflection and (4) sawing joints and sealing the sawcuts in asphalt overlay to control reflective cracking. A brief follow-up study was conducted to evaluate the feasibility of using the additional practices in nighttime construction. In addition, a review was made of the construction practices reported in RD-76-221 in an effort to modify and improve the practices. In the follow-up study information from five additional airport projects was obtained and analyzed. A summary of information from the five airport projects is reported in Appendix C.

The modified and updated technical data and recommended practices are provided in Section 2 and Section 3, respectively, and supercede the data and practices reported in RD-76-221. Asterisks are placed in various parts of Sections 2, 3 and 4 to show which data, practices and conclusion reported in RD-76-221 were modified and updated or added.

Coordination of the Overlay Project by Airport Director's Representative

It is of the utmost importance that the representative of the airport director in charge of the work, either a consulting engineer or an employee of the airport authority, be familiar with the various airline operations of the airport and have the necessary judgement to schedule the contractor's activities accordingly. The specific duties of the airport director's representative should be as follows:

1. Check with the weather bureau prior to 8:00 p.m. to ascertain if weather conditions would be suitable for the contractor's work that night. It is important to know the minimum temperature predicted for the night, if rainfall is expected, and to be aware of any possibility of fog "creeping in" during the night, thus causing IFR conditions.
2. The airport director's representative should evaluate the weather conditions to determine whether to direct the contractor to work or not. It should be the policy of the airports director's representative to follow the weather bureau's forecast. Any weather bureau report predicting a chance of rainfall greater than 50% should be cause for suspension of work for the night. There should never be an attempt to outguess the weather bureau. There could be instances based on information from the weather bureau that work was suspended but actually no rain fell and the sky was clear; however, it is critical that all decisions on this matter be on the safe side in order to prevent interruption of flight schedules.
3. After the contractor has reported for work, it is necessary that the airport director's representative check with each airline independently to see if all arriving and departing flights would be completed by 11:00 p.m. which would require the use of the primary runway. Each airline operations chief should be given a letter size sketch showing the work area for each night. The FAA air traffic control chief should also be given a copy of the sketch.

4. At the start of the night's work, the airport authority representative should confer with the contractor's project superintendent and there should be an agreement made as to how much work to layout for the night in order to insure the opening of the runway promptly at the specified time each morning. It is necessary that the amount of work be strictly controlled in order to prevent the contractor from becoming "over ambitious" and unable to finish the work within the allotted time. This is especially true in areas where pavement repair and replacement are to take place.

5. At the completion of work each morning and before the opening of the runway each morning, the airport director's representative should pick up representatives of the various airlines for an inspection of the runway before opening to aircraft traffic. It is mandatory that no FOD be on the runway and the inspection should satisfy the airlines.

6. All contacts with the U. S. Weather Bureau, the Federal Aviation Administration and the airlines should be made by the airport director's representative. The contractor should not be allowed to directly contact or have any dealings with the above listed organizations.

Nighttime Working Hours

Time is of the essence on nighttime construction. The contractor should be given as much time as possible to overlay the runway each night. A period of time from 11:00 p.m. to 6:30 a.m. should be the least specified and if possible the flight schedules should be altered to permit closing of the runway at 10:00 p.m. with the opening of the runway scheduled for 7:00 a.m.

In no event should any work normally start later than 11:00 p.m. in the contract specifications; however, in the case of standby delays, work could be permitted to start as late as 1:00 a.m.

The scheduling of the work on one of the runways to commence each night at 11:00 p.m. should be predicated on the following conditions:

1. Arrival of the last aircraft at the airport as scheduled prior to 11:00 p.m.
2. Departure of the last aircraft from the airport as scheduled prior to 11:00 p.m.
3. Unrestricted use of one of the runway facilities for operation of aircraft which would permit the closing of the other runway for overlay operations. With approval of the airport authority, the airport could be closed during construction operations at night.

The contractor should be told that delays or suspension of construction activities might be expected during the time allowed for the night work period on account of the following conditions arising which would be beyond the control of the airport director:

1. Arrival of the last aircraft at the airport after 11:00 p.m.
2. Delayed departure of jet aircraft from the airport after 11:00 p.m.
3. Weather conditions which require the use of the runway being overlayed for instrument operation of aircraft.
4. Wind directions and velocities which necessitate the use of the overlayed runway for the operation of aircraft. This is only necessary when it is agreed to keep other runway facilities open during construction operations.

In order to compensate the contractor for the delays outlined above the following bid items should be included in the contract specifications:

1. Suspension time - This item should be specified to compensate the contractor for the notification by the proper authorities not later than 8:00 p.m. that work for the entire night will be suspended. This notification will allow the contractor sufficient time to alert personnel not to report for work as scheduled. The contractor should be required to bid on "suspension time" by the sum per night for such delays. The bid schedule should contain an estimated amount of "suspension time" which might be anticipated.

2. Standby time - This item should be specified to compensate the contractor when he reports for work, after having received no notification prior to 8:00 p.m. that activities for the night would be suspended. After having reported for work, the contractor, if notified by the proper authorities, should be paid by the hour for "standby time" for a period not later than 1:00 a.m. of the work night. The contractor should be required to bid on "standby time" by the sum per hour. The bid schedule should contain an estimated amount of "standby time" which might be anticipated.

3. Down time - This item should be specified to compensate the contractor for the condition which arises when the contractor has stood by until 1:00 a.m. and then is notified that no work will be performed that night and will be paid for "down time" for the remainder of the night. The contractor should be required to bid on "down time" by the hour for such delays. The bid schedule should contain an estimated amount of "down time" which might be anticipated.

The inclusion of suspension, standby, and down time in the bid schedule is the best means to secure the lowest bid price for the construction of the project. By this method, the contractor does not have to assume delays in his bid which will increase the cost of the project.

Standby Equipment

The contractor should be required to provide standby equipment at the construction site for all work included in the specifications. The standby equipment shall be provided for all types of equipment to be used in the required construction operations. The proper authorities may require that the standby equipment be interchanged with the regular construction equipment. Operators should not be required for the standby equipment. The standby equipment should not be used except in the case of emergencies or regular equipment breakdown. The standby equipment should be listed in the daily equipment as usually required by the contract specifications. When standby equipment is required to be used, the contractor should be required to promptly repair or replace the broken equipment before being allowed to proceed with the next night's work. The standby equipment should be required in the following amounts:

Regular Equipment Used

1 - 6 units
7 or more units

Standby Equipment Required

1 unit
2 units

In all cases the contractor should be required to park standby equipment readily available to the construction area in the event of breakdown of the regular equipment. Suitable equipment should be provided for the rapid movement of the asphalt spreaders and in no event should crawl-type spreaders be allowed to transverse grassed areas.

Obstruction Lighting and Barricades

At the beginning of each night's work and after having received instructions to proceed with the work from the engineer in charge of the airport director's representative, the contractor should place all illuminated traffic cones to blockoff any connecting taxiways if required.

At the end of each night's work all illuminated traffic cones must be removed from the runway and stored in the contractor's work area outside the approach zone of the runway.

The illuminated traffic cones should be fabricated of highly pigmented translucent, fluorescent red-orange polyvinyl chloride. Each cone should be a minimum of 28 inches high and the bottom inside diameter of the cone should be not less than 10.5". The base should be of sufficient weight and size or should be anchored in such manner that the traffic cones will stay upright in strong wind encountered at the site.

The cones should be illuminated by setting each cone over an operating lighting unit placed directly on the pavement. The lighting unit should consist of one or more 6-volt dry cell batteries and a #27 lamp. The lamp should be amber unless directed otherwise by the airport authorities. The battery should be of sufficient capacity to operate the lamp at full brilliancy for a minimum of 5 hours and should be provided with a polarized receptacle on top which will accommodate a lamp socket and lamp.

The contractor should replace batteries in the lighting units when the brilliancy of the lamps becomes inadequate as determined by the engineer. If any light in the cone fails or the cone is damaged, displaced or not in an upright position, from any cause, the engineer in charge should require immediate correction.

In lieu of illuminated traffic cones, the contractor should be allowed to use old railroad ties with a flashing amber light on each end of the railroad tie. The front of the railroad ties should be marked with 6 inch wide white and international orange stripes. The entire height of the barricade should not exceed 16 inches. The barricades should be spaced about 10 feet apart.

Construction Lighting

The Contractor should be required to install, maintain and relocate temporary light to illuminate the working areas during the hours of darkness when overlay operations are in progress.

The lighting equipment should be trailer mounted units, each with four 1,000 watt metal halide or high pressure sodium lights on a winch-lift telescopic mast. The Contractor should provide sufficient units to have the capacity of producing an average maintained illumination level of 5 horizontal foot candles throughout the working area. The Contractor should be required to submit isolux curves or charts showing the pattern of lights. Levels should be calculated and measured in accordance with the standards of Illumination Engineering Society (IES) current practice.

In addition, all paving machines, rollers, distributor trucks and other equipment (except haul trucks) should be equipped with artificial illumination sufficient to safely complete the work.

Minimum illumination level should be 5 horizontal foot candles and should be maintained in the following areas:

1. An area 25' wide and 12' long immediately behind the asphalt spreader during the operation of the machine
2. An area 12' wide by 30' long immediately in front and back of all rolling equipment during the operation of the equipment.
3. An area 12' wide by 12' long at any point where tack coat is being placed prior to placement of the hot mix asphaltic overlay.
- * 4. An area 12' wide by 20' long immediately in front of the cold milling machine

- * 5. An area 12' wide by 30' long immediately in front of the heater scarifier and heater planing machine.
- * 6. An area 12' wide by 30' long in front of the rubber asphalt distributor and spreading equipment.
- * 7. An area 12' wide by 12' long at any point where joint sealing operations are in progress.

The level of illumination can be obtained with four 1,000 watt metal halide floodlights at 30' mast height aimed at 60 degrees and placed at approximately 200' centers along each edge of the runway.

A 1,000 watt lamp in metal halide produces 111,000 initial lumens while the 1,000 watt lamp in high pressure sodium produces 140,000 lumens. However, the color correction in metal halide is considered better and actually whiter. The high pressure sodium light is one that produces a sort of golden light. The metal halide lamp actually gives a more nearly daylight effect.

- * The requirements for lighting should be strictly enforced by the Engineer in Charge. Insufficient light will result in an objectionable overlay project as there will not be sufficient light to properly observe the placement and compaction of material.

Asphalt Compaction Equipment and Density Control Strips.

The compaction equipment should be capable of obtaining the specified density without detrimentally affecting the hot mix asphaltic concrete overlay. The equipment should be modern efficient compacting units satisfactory to the Engineer in Charge.

It is generally agreed that roller techniques and operator capabilities are the two most important elements in compaction operations. Compaction techniques for hot mix asphaltic concrete pavements generally are initial rolling (breakdown) that follow the spreading operation immediately or as soon as possible thereafter, as densities are achieved at higher temperatures. Breakdown with static rollers should begin with material temperature of 250° to 260° F. Static rolling on materials above 260° F will have a tendency to create a longitudinal displacement condition. Further intermediate and final rolling is delayed because marked cooling of the compacted course is necessary. Otherwise, serious displacement and surface checking may result.

Although there will be variations due to aggregate size and bitumen content, the following rolling temperatures are a suggestion for ideal compaction of the hot asphaltic mixture.

1. Breakdown with 3 wheel or tandem roller at 260 degrees F. (plus or minus 15 degrees F.)
2. Intermediate rolling with pneumatic tires rollers at 200 degrees F. (plus or minus 15 degrees F)
3. Finish rolling with tandem roller at 175 degrees F. (plus or minus 15 degrees F.)

Atmospheric conditions, viscosity and equipment variations may alter the above temperature limitations somewhat. This is especially true for the nighttime construction where lower temperatures can be expected. Vibratory rolling of the hot mix asphaltic mixture has been performed in overlay projects with success. In general, vibratory rollers exert considerably more compactive effort per pass than do the conventional static rollers. Consequently, a fewer number of passes are required to achieve maximum density. Rolling patterns therefore are much more critical and should be determined for each overlay project by the use of density strips. It is considered necessary to establish density-increase patterns through the use of nuclear-density tests. With greater forces applied to the surface by vibrating rollers, over-rolling can be as much of a problem as too little rolling. Once optimum density is obtained, additional passes of the vibrating roller can crush the large aggregate particles and result in a subsequent loss in density.

Vibratory rolling should not be used for compacting thin overlays of less than 1 1/2 inches. In thin overlays, there is not enough material to absorb the energy generated by the vibrating rollers. The energy passes through the mix being compacted may rebound from the surface of the pavement being overlaid. The rebounding energy can decrease the density. For this type of situation, the vibratory roller should be used in the static mode at a speed not to exceed 3 miles per hour. The importance of operator experience on all compaction equipment and particularly on vibrating rollers cannot be over-emphasized. With the many variables involved in obtaining a dense, smooth hot mix asphaltic concrete surface, it is extremely important that the operator follow good established compaction procedures and make the required number of passes over all overlaid areas.

If possible, density control strips should be constructed to determine the target density, optimum temperatures, compaction procedures and number of passes for proper compaction of the hot mix asphaltic concrete. This density control should be constructed under nighttime conditions on areas

other than the runway to be overlaid. The control strip should be the width of the paver and approximately 300 ft. long and should be the same depth as the overlay course. The density of the compacted mixture should be determined by means of a portable nuclear density test device in accordance with ASTM D-2950 or AASHTO T-238.

* Experience has shown that nuclear gauges when used in the backscatter mode on thin overlays have certain restrictions which must be recognized in order to obtain correct densities. Instructions issued by manufacturers of nuclear gauges should be followed in making density tests.

* In order to verify the nuclear gauge reading, cores should be taken and remolded and compared to the laboratory density.

Upon completion of the compaction, the mean density of the control strip should be determined by averaging the results of ten nuclear density tests taken at randomly selected sites within the control strip. The mean density of the control strip should be the target density of the remainder of the course it represents. If the mean density of the control strip is less than 98% of the density of laboratory compacted specimen of the same mixture the Engineer in Charge should take corrective measures such as additional rolling or change in mix design.

It is important on nighttime overlay construction that the Engineer in Charge designate an inspector full time to check the rolling operations.

Installation of In-Runway Lighting Fixtures

In-runway fixtures can be installed along with the hot mix asphaltic concrete overlay. The overlay presents an excellent opportunity to replace high maintenance costs of inset light systems with a pavement integrated conduit system.

The in-runway lighting system may be installed in the following manner:

1. A conduit system should replace a saw-kerf and wire system.
2. An opening should be bored in the existing asphalt pavement and light fixture base set and the space between coring and light fixture filled with compound compatible with the asphalt.
3. Slot for the conduit as required should be sawed in the direction desired and after the conduit is placed, the slot should be filled with a quick-set sealing compound.
4. After sawing is completed, the overlay should be cored directly over the base and an extension installed.

After the overlay is completed, it is usually difficult to locate the light bases which are buried and out of sight. It takes excellent surveying technique to plan and place inset monolithic lighting. One scheme for locating bases is to provide a temporary plywood cover which protrudes slightly above the surface. When the hot mix asphaltic concrete overlay is placed the "shadow effect" causes a reflection in the surface to visibly locate the exact location to core. Since the coring removes more than the material of low density, no lasting damage is caused by having insufficient compaction at this point.

The compound used to seal around the light bases and to fill slots for the conduits should be a type manufactured for that particular purpose and be entirely compatible with the hot mix asphaltic concrete overlay. An instance has been reported where the material to be used around conduits swelled to such an extent that objectionable bumps were caused in the pavement every 50'. The conduit system and light bases should be installed at nighttime with the same construction period as for the runway. Time is of essence in placing these light fixtures and conduits, and this particular requirement should be clearly pointed out in the specification.

Precaution in Construction.

There have been instances where the completed overlays were somewhat less than satisfactory. Detailed studies of various jobs indicate that the following factors contributed to the unsatisfactory overlay.

1. Lack of grade control. It was found that the specification for the overlay project did not contain a clause requiring the Contractor to construct the overlay to the plan grade with tolerances applied. The tolerance of the finished surface should be within 0.02 and 0.03 hundredths of a foot of plan grade. This tolerance, however, cannot be achieved in a single lift of the asphaltic concrete mixture.

* Multiple lifts will be required to achieve this close tolerance. In one reported instance, the grade of the runway varied from three to four inches off the planned grade, with some areas being low and some areas high. Extensive straightedge inspection will not correct pavements which are way off grade. The proper way to control the grade is to require erected stringline for all courses of the overlay. These grades should be checked each morning before the runway is opened to airline traffic, and results reported daily to the Engineer in Charge. If it is found that the intermediate courses are within tolerances specified, consideration might be given to the placing of the final course by the use of the traveling stringline method.

2. Construction period was too short. The most critical areas in the surface course of the overlay occurs at the transverse joints at the end of each night's overlay. These joints are always difficult to construct and could cause rough areas in the pavement unless extreme care is taken during construction. The construction should be planned so that approximately 800' of overlay or more is placed each night. This will mean that the Contractor should be scheduled to start work not later than 10.00PM and to open the runway to aircraft traffic promptly at 7.00AM the next morning. Construction operations should not be scheduled, in general, to begin later than 11.00PM.

3. Failure to properly design intersections at runways. All intersections should be carefully contoured so that elevations of the overlay can be readily determined.

* Centerline longitudinal grade changes in excess of 0.1667 percent should not be allowed.

4. Failure to construct proper transition. Failure to construct the proper transition at the end of nighttime paving operations have been the complaint of pilots upon landing on the newly placed hot mix asphaltic concrete overlay. Reported incidents of damage to the aircraft landing gear due to short transitions and transitions being dislodged by jet aircraft blast have been reported. Details for construction of the transition are contained in Section 3 "Recommended Construction Practices".

5. Failure to provide proper transverse slope for drainage. Poor drainage of the runway overlay will occur unless the transverse slope of the runway overlay is one percent or preferably one-half percent. In the event the runway is side-sloped with a transverse slope of less than one percent, consideration should be given to providing a third point or quarter point crown with transverse slopes not less than one percent.

6. Raked and "cast-on" areas on pavement. Excessive raking of the final surface of the hot mix asphaltic concrete overlay should not be allowed. Raking and "casting on" of the mix could result in nests of segregated aggregate which could be dislodged by jet blasts or disturbed by grooving operations.

7. Inadequate inspection and testing. It is important that the inspection and testing materials for nighttime overlay construction be carried on in such manner as to assure strict compliance with the

specifications. *Failure to do so will result in an unsatisfactory product. The inspection personnel should be familiar with the lighting conditions at night reflect on the asphalt pavement and greatly magnifies ridges and depressions. The inspector should at all times be cognizant of the strict time for the opening of the runway and should assure himself each night that the construction schedule can be met.

Premium Costs for Nighttime Construction.

It must be realized that there is some premium costs involved in nighttime construction. Each project should be analysed for extra costs over and above what daytime construction would cost.

Following are items of premium cost to be considered in arriving at the cost of nighttime construction.

1. Materials. There should not be any difference in costs for materials whether the hot mix asphaltic concrete overlay is placed in the daytime or nighttime. Aggregates and bitumen may be delivered to the plant during the daytime.
2. Labor for Paving. Normally it could be expected that some incentive should be used to influence the performance of the nighttime overlay. For example, if the Contractor works 8 hours per night the Contractor's personnel could be paid for 9 hours. There should not be any across-the-board pay increase for nighttime work. In the event the Contractor works 6 nights a week, there will be overtime on the sixth night. The Contractor may be subjected to special union rules for nighttime work and this possibility should be thoroughly investigated before preparing cost estimates.

* Under no circumstances should the Contractor attempt to work 7 nights a week as production will be so low as not to warrant the extra cost.
3. Labor for Electrical Work. It has been found that the electrical work involved in connection with in-runway lighting involves specialized labor. In order for this skilled labor to work at night, time and a half pay is usually necessary.
4. Lighting Costs. Extra costs will be incurred for lighting of the runway during nighttime construction periods and also for the cost of providing lights on the asphalt spreader and rolling equipment. It is possible for the Contractor to rent the four 1,000 watt lighting units

as hereinbefore described.

* Based on 1981 rental prices, it is estimated that one lighting unit will rent for about \$1,000 per month, exclusive of operating costs, including fuel and moving of the portable lighting fixtures. Extra cost will also be incurred in providing lights for the asphalt spreading machine and rolling equipment.

5. Estimating Premium Costs. When the preliminary project estimate is being prepared, the various Contractors in the area should be questioned as to what they expect to be the extra cost for night-time construction. It will be apparent that the idea of extra costs among the Contractors will vary to a great extent. It is probable that some of the Contractors will report a rather high premium cost which should be discounted. When the project is actually advertised and bids received, the Contractors will reflect the premium costs in their bids which will be approximately 10% to 20% higher than daytime construction costs. Based on experience, the costs will be substantially lower than the cost quoted to the Engineer at the time of the preparation of plans and specifications.

Pre-bid Conference.

A pre-bid conference should be held approximately two weeks before receipt of bids to acquaint all prospective bidders with the details of the work and to answer all questions. The conference should be attended by the following:

- Airport Director or his Authorized Agent.
- Public Works Representative
- Consulting Engineer
- Contractors bidding on the project
- Federal Aviation Administration Representative
- Control Tower Chief
- Crash Crew Chief
- Security Chief
- Representatives of Various Airlines
- Testing Laboratory Representatives.

SECTION 3

RECOMMENDED CONSTRUCTION PRACTICES

Pre-Construction Conference.

Prior to the start of the overlay construction, the Airport Authority should require that a pre-construction conference be held to discuss the features, requirements and details for nighttime construction.

The Airport Director or his authorized representative, who is also the Engineer in Charge, should discuss in detail the various safety requirements of the airport. The Contractor should be made cognizant of the fact that he will be working in designated areas and that employees will be required to stay within these designated areas. All personnel of the Contractor should be required to park their personal automobiles in a certain area designated for that purpose.

The following items should be discussed in detail with the Contractor:

1. Haul Routes. The location of haul routes should be discussed with the Contractor, and decisions should be made on security, safety, responsibility of truck drivers transporting the asphalt mix and other items involved in the construction.
2. Working Hours. The exact working hours should be agreed upon so that notices can be given to the Federal Aviation Administration for distribution to the proper authorities.
3. Communication with FAA Control Tower. The Contractor should be made aware that all communications with the FAA Tower personnel will be made through the Airport Director's representative and not by the Contractor. This is important as the number of people having contact with the tower should be limited in order to prevent misunderstanding or conflicting information. The Airport Director's representative should have direct radio contact with the FAA tower and all requests for closing and opening of the runway should be made by the Airport Director's representative.
4. Designation of Work Areas. Prior to the start of overlay operations each night, the Airport Director's representative should discuss the

area to be worked, and the Contractor's Superintendent should mark on a letter-sized drawing the exact limits of the area to be repaired or overlaid. This drawing, marked as required, should be hand-carried to the Airport Director, FAA Control Tower Chief and the Station Manager of the various airlines.

5. Security During Construction. Prior to the start of construction all personnel and suppliers should be given a drawing showing the haul routes, active runways (if any) and any other details pertinent to the overlay operations. The drawing should contain a note which states that anyone found in restricted areas or crossing active runways will be promptly and permanently removed from the job.

During the overlay operations, the Contractor must provide strict security. This security should apply to all personnel at the overlay site and also to truck drivers hauling materials and equipment. In the event there is an active runway in the area, all personnel should be cautioned, indeed ordered, not to cross the active runways. At the intersection of active and closed runways, the Contractor should erect adequate lighted barricades to prevent vehicles from crossing active runways.

* Safety Plan

The Airport Director should furnish the airlines, fixed base operators and control tower personnel a bound booklet identified as a "Safety Plan" which should include the following:

1. Identify the projects included in the safety plan.
2. Operational safety during construction.
3. Construction activity and aircraft movements.
4. Limitations on construction.
5. Identification of Contractor's vehicles.
6. Safety consideration discussed at pre-construction conference.
7. Construction sequence.
8. Reduced 8 1/2" x 11" plan drawings as required to show the area and progress of work.

Construction Schedule

Prior to commencing work on the nighttime overlay project, the Contractor should be required to file the following with the Airport Director for approval.

1. A detailed progress schedule showing the proposed schedule of work
2. A complete list of equipment to be used, including standby equipment as required by the specifications.
3. Evidence that the central hot mix asphalt plant(s) meet the requirements of the specifications.
4. Evidence that the amount of hot mix asphaltic concrete the Contractor proposes to place can be supplied to the job in the time required.
5. Experience record of the project Superintendent the Contractor proposes to place in charge of the job. The experience record should list his experience on hot mix asphaltic concrete overlays, including any nighttime construction.

Assembling of Equipment for Nighttime Overlay Operations.

When the Contractor is advised by the Airport Director's representative that the night's work may proceed as contemplated, the Contractor should assemble all personnel and equipment as close as possible to the work area. The equipment and personnel should be organized and ready so that when notice is given, the Contractor's personnel, including the survey crew, can proceed immediately to the runway.

All hot mix plants should be operating and ready to proceed with the production of the hot mix asphaltic concrete material.

The Contractor should be assured that all equipment, including standby, is in operating condition and ready to go.

Limits of Repair and Overlay Operations

The plans and specifications should show the exact limits of repair and overlay and should indicate the amount of asphaltic concrete fill required

at specified intervals. An example of the tabulation of the full requirements is shown on sheets 12, 13 and 14 of Appendix "D".

- * Prior to overlay the pavement should be repaired as outlined in Appendix "A" Level Surveys and Plan Preparation.

In order to complete the overlay within the shortest time possible, the Contractor should be required to place approximately 800 feet of overlay each night. This amount is predicated on the runway being available at 10.00 PM and opened for air traffic the next morning at 7.00 AM. By placing 800 linear feet of overlay each night regardless of the width of overlay, the number of transverse joints will be held to a minimum. The whole width of the runway must be overlaid as shown by Figure 1, with the exception that on a 200 ft. wide runway, the asphaltic concrete overlay should be placed as shown in Figure 2.

- * If acceptable to the Airport Director, consideration should be given to placing a 50 ft. strip down the center of the runway for a pre-determined length provided the runway is center crowned. The pavement should be placed in accordance with the details shown on Figure 3. By placing the center 50 first and holding the depth of the layer to 1 1/2 inches, no transition will be required as noted on Figure 3.

In preparing plans and specifications for the overlay project, the Designer should ascertain the availability of hot mix asphalt plants in the area and the tonnage that the plant will produce. In instances where the overlay is thick enough to require several intermediate courses the plant capacity will be most important. The Designer, after determining plant capacities, can compute the thickness of the intermediate course or courses which should generally not be greater than 3 inches compacted thickness.

Application of Tack Coat.

Tack coat should be applied on the existing pavement immediately prior to overlay operations. In all cases, the tack coat should be emulsified asphalt. The tack coat should also be applied to intermediate courses unless one overlay application immediately follows the other. Elimination of tack coat on intermediate layers has in some known cases, caused slippage of the subsequent layers.

- * Application of Stress Absorbing Membranes.

In order to deter crack reflection there have been instances where a single asphalt treatment has been used, successfully. See Appendix A for details.

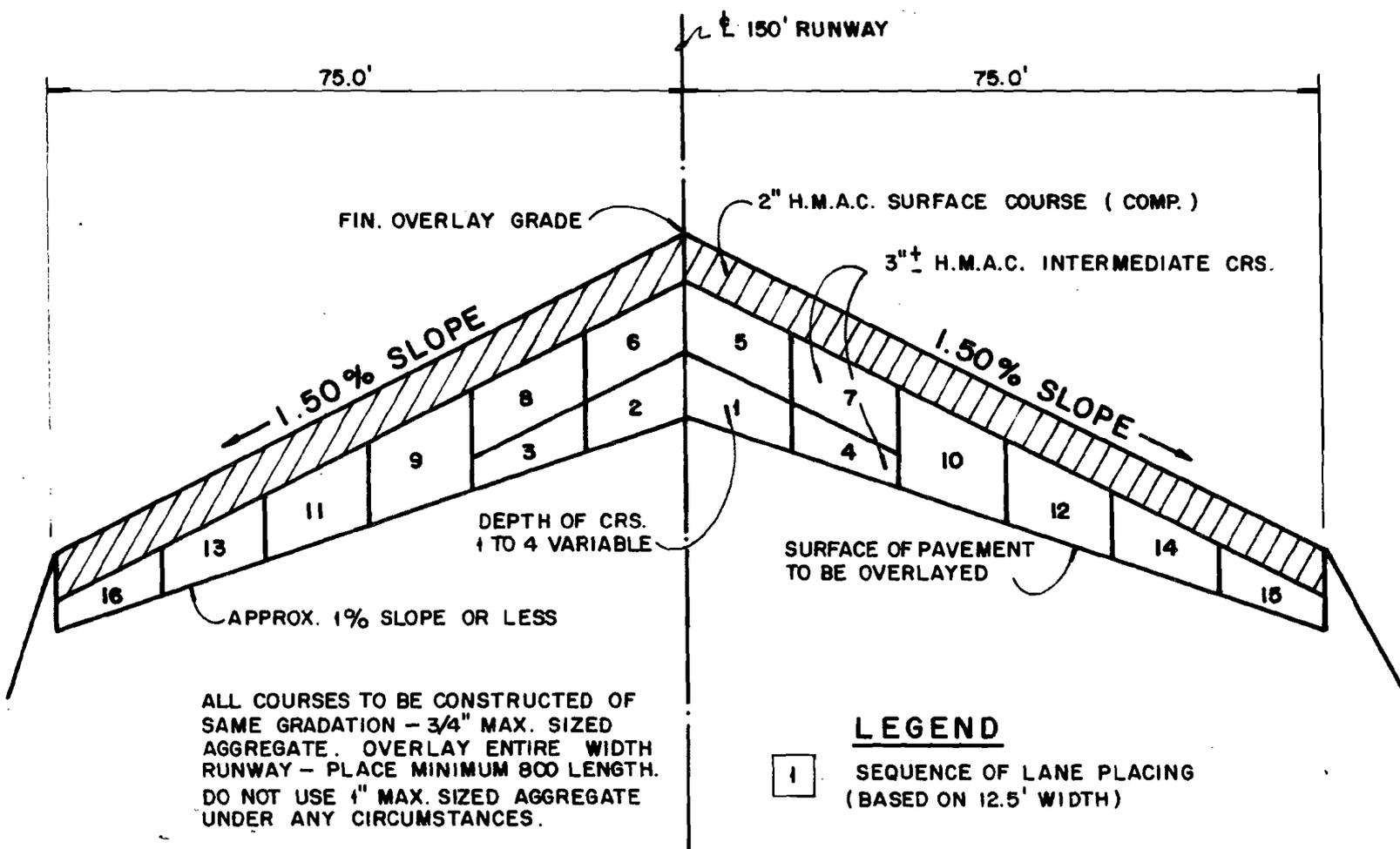
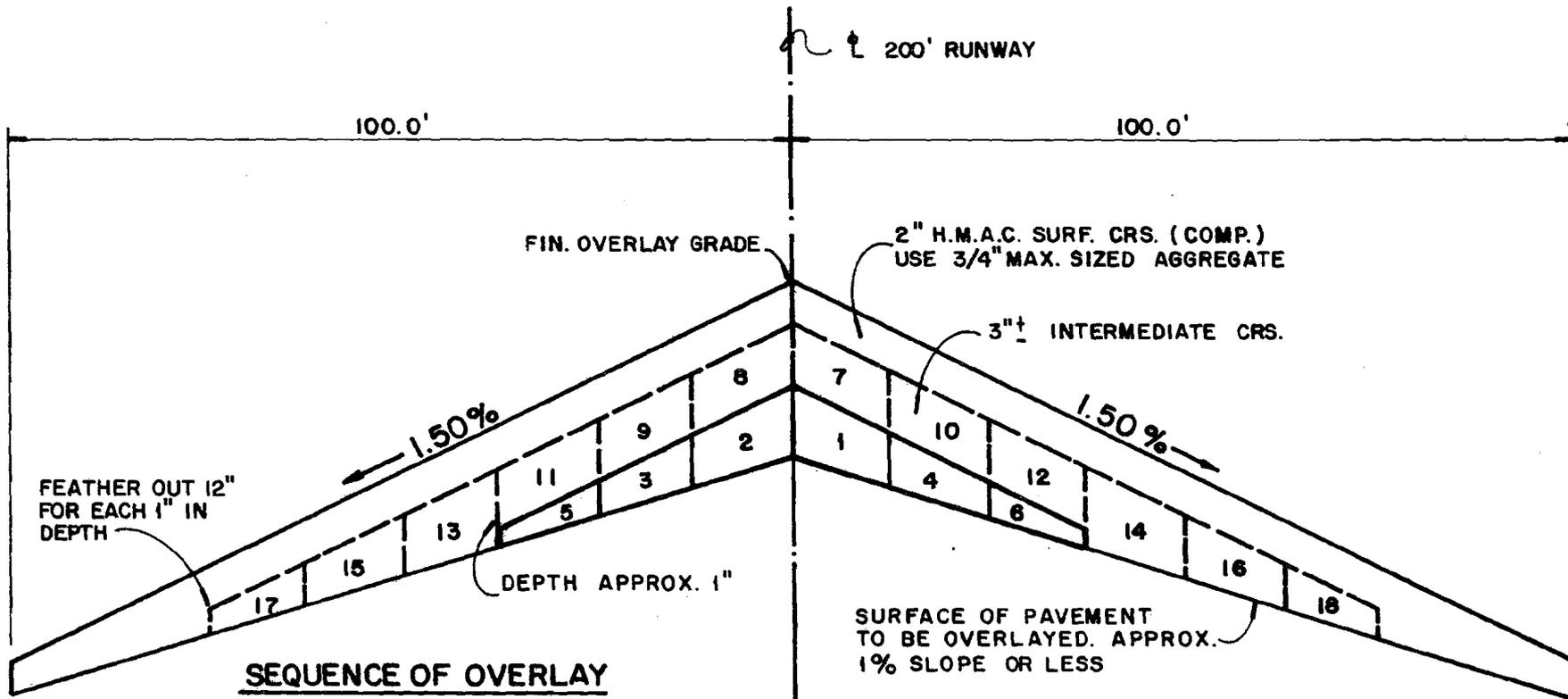


FIGURE 1 - TYPICAL OVERLAY SECTION (150' RUNWAY)
 NOT TO SCALE



SEQUENCE OF OVERLAY

1. PLACE LANES 1-6 INCL. FIRST FOR ENTIRE LENGTH RWY. (800 MIN. PLACING.)
2. PLACE LANES 7-18 SECONDLY SAME DISTANCE AS SPECIFIED ABOVE.

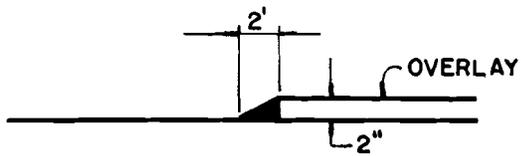
LEGEND

1 SEQUENCE OF LANE PLACING (BASED ON 12.5' WIDTH)

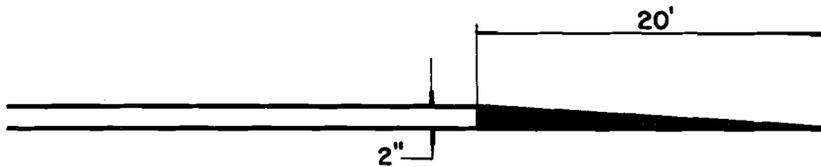
NOTE: DO NOT USE 1" MAX. SIZED AGGREGATE UNDER ANY CIRCUMSTANCES.

FIGURE 2 - TYPICAL OVERLAY SECTION (200' RUNWAY)

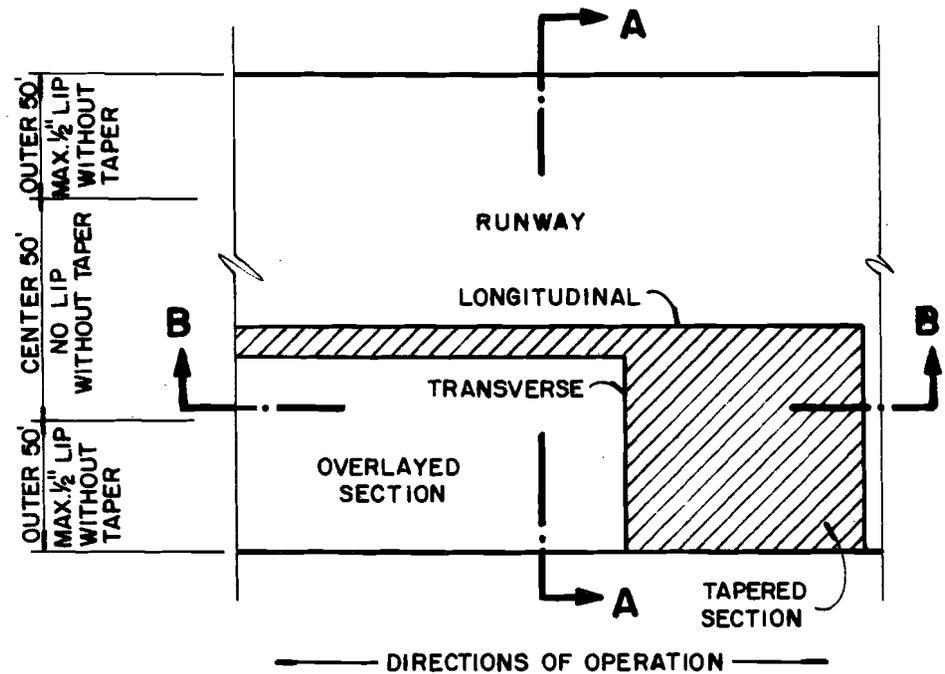
NOTE TO SCALE



Section A-A (Longitudinal Lip)



Section B-B (Transverse Lip)



Plan of Overlay

GENERAL NOTES

1. NO LONGITUDINAL LIP IN THE CENTER 50' OF THE RUNWAY. PROVIDE A MINIMUM TAPER OF 1' FOR EVERY 1" OF DIFFERENCE IN LEVEL. IN THE OUTER 50', PROVIDE A MAXIMUM DIFFERENCE IN LEVEL OF LIP OF 1 1/2"; IF GREATER, A TAPER OF 1' FOR EVERY 1" DIFFERENCE IN LEVEL AS ABOVE IS REQUIRED.
2. TRANSVERSE LIP SHALL BE TAPERED WITH A TAPER OF 10' FOR EVERY 1" DIFFERENCE IN LEVEL.

FIGURE 3 - PAVEMENT OVERLAY PLACEMENT DETAILS

Setting the Erected Stringline.

The Airport Director's representative should furnish the Contractor a tabulation of the asphalt fill as required for the night's overlay operations. The tabulation should show the asphaltic concrete fill requirements every 25' longitudinally and every 12.5' or 25' transversely depending on the width of the asphalt spreader. The Contractor should be responsible for all surveys.

The setting of the erected stringline for the various layers are as follows:

1. Bottom or Leveling Course. When erected stringlines are used for the bottom course or leveling course, the height of the fill should include an allowance of 3/16" per inch thickness to allow for rolldown. In other words, the stringline will be placed at the loose elevation of the mat. The erected stringline should be supported every 25' by pins welded to approximate 8" square metal plates with adjustable arms. The grade pins should be so designed as to allow the stringline to be secured to the adjustable arm without any protrusion above the stringline grade. The stringline should be set, anchored and adjusted to the required grade and maintained with a force no less than 80 lbs pull to prevent sag of the stringline. The anchoring of the stringline should not exceed 500'.

For the leveling course, it is recommended that spot leveling should not be used as it will be too difficult to feather the edges in isolated areas. It is also recommended that the runway, if a parallel runway exists, not be closed for leveling courses to be constructed in the daytime. The closing of one parallel runway in the daytime will cause too many delays in airline flight operations. The leveling course can be placed along with the subsequent course by the method of placing the stringline at the rolldown elevation. In order for a precise checking of the hot mix asphaltic concrete mat during placement, the stringline should be placed at the same elevation of loose mat. By this method, it will be easy to measure from the stringline to the loose mat by use of a carpenter's level. In some instances, the stringline has been set from 4" to 18" above the required elevation. The placing of the stringline above the desired grade makes it difficult to measure down to check the mat elevation, and should not be used.

It is possible to place the hot mix asphaltic concrete overlay within 0.02' to 0.03' of the plan grade if the following procedure is used.

During the placing of the hot mix asphaltic concrete overlay, the Contractor should constantly check both sides of the mat (for the initial lane placed) by the measuring over from the stringline to the mat to determine grade compliance and by making the necessary adjustment in the electronic control devices. Immediately after rolling operations are completed, the Contractor's field supervisor should determine the elevations of the pavement. These elevations should be taken - with a rod and level, every 25' transversely and every 12.5' or 25' longitudinally depending on the width of the asphalt spreader. The Contractor should compare the "as built" elevations with the plan grades to determine if the 3/16" per inch rolldown assumption used is acceptable. The Contractor should then furnish the Airport Director's representative with a copy of the grade elevations of the bottom course.

* For paving lanes after the initial lane, the elevations should be taken transversely every 25 feet along the new edge.

2. Intermediate Courses. After placing the bottom course for the length of the runway, the Contractor should be ready to commence with the intermediate course or courses. The Airport Director's representative should furnish the Contractor with another copy of the asphalt fill for the intermediate course which should be the difference between the plan elevation and the elevation of the "as built" elevation of the bottom course plus 3/16" per inch for roll-down. During, and after, placing of the intermediate course, grade and elevation checks should be made as hereinbefore outlined for the bottom course. Each intermediate course should be held to an approximate compacted depth of 3 inches.

The procedures should be repeated for as many intermediate courses as required with close grade control exercised. The top or surface course placed should be 1-1/2 to 2 inches of compacted thickness.

* If the final intermediate course is found to be constructed to within 0.02' or 0.03' of the planned grade, it is recommended that the final course be placed using a traveling stringline. Otherwise, the Contractor should be required to use an erected stringline.

The importance of strict grade control of all the courses of the overlay cannot be overemphasized. The best asphalt mix design and the best results on compaction are not sufficient if the overlay is not constructed to the plan grade. It should be the responsibility of the Airport Director's representative to assure himself that the Contractor is exerting care in his grade control.

Traveling Stringline Operations.

If the runway is considered to be sufficiently smooth, the Contractor should be permitted to place the hot mix asphaltic concrete overlay by the use of a traveling stringline.

* At present, no criteria exist when a runway is sufficiently smooth for a traveling stringline. Consequently, engineering judgement should be used for this determination. The decision to use traveling stringline should be reviewed and changed, if necessary, after reviewing the "as built" elevations of the initial lane.

The traveling stringline may consist of a 30' to 45' ski, a wheel device or footed frame or similar device. When asphalt pavers are operated in echelon, the first paver will have a traveling stringline on both sides and the following paver will be equipped with a matching shoe and traveling stringline.

In no circumstances should the slope control device be used, since the accumulative error in multiple lane paving will violate the grade control criteria. It should be pointed out that the use of a traveling stringline will expedite the placing of the material as no setup time is required at the start of nighttime operations. It can be reasonably assumed that approximately 30 minutes will be saved by using the traveling stringline method rather than the erected stringline.

Asphalt Placing Operations.

Prior to the start of the night's hot mix asphaltic concrete overlay operations, the Airport Director's representative and the Contractor's project Superintendent should agree on the limits of the runway to be overlaid. As hereinbefore stated, the target length to be paved each night should be 800' regardless of the depth of the particular course being placed that night. If conditions permit and the plant production is adequate, the length of the final course could be increased if placed by traveling stringline.

The Contractor should begin placing the hot mix asphaltic concrete overlay in the direction of the usual prevailing wind so that the aircraft will be landing down the transition. There should be no skipping of sections. The overlay should cover the full width and a distance of 800' of the runway each night with the exception of a 200' wide runway. The asphaltic concrete should be placed in the sequence of lanes shown in Figures 1 and 2.

The Contractor should operate two or more paving spreaders in echelon with either 12.5' or 25' paving widths, and the spreaders should be supplied with hot mix asphaltic concrete from two plants, if necessary. For the final 1 1/2 to 2 inch course, the first pass should be centered on the middle of the runway and each succeeding pass should proceed towards the edge of the runway. No overlay should be permitted in excess of the capacity of the plants and paving spreaders. In the event that the two plants cannot supply sufficient amount of material for the 25' wide spreaders, the Contractor should consider using only 12.5' wide placing. In no event, should only one spreader be permitted as two or more spreaders operating in echelon are necessary to maintain a hot joint during nighttime paving operations. For close grade control, it will be found that the asphaltic concrete material placed with 12.5' wide spreaders will be more accurate.

- * In the event consideration is given to placing a 50 foot strip down the centerline of the runway as the first operation, the depth of the overlay should be controlled as indicated on Figure 3.

The Contractor should hold raking to the very minimum and casting of raked material on the mat should be prohibited. This restriction should also apply to the intermediate courses.

Compaction Requirements.

The compaction requirements should be outlined in the specifications and test control strips should be constructed as hereinbefore described. Rolling should secure a density in the mat of at least 98% of the laboratory density of the same mixture.

Two pavers operating in echelon should produce a hot joint for rolling operations. In echelon paving and rolling is sometimes a problem, as it is difficult to maintain a rolling pattern due to the congestion of the two pavers placing 12.5' lanes. This could be especially true of the rolling by the heavy pneumatic tired rollers. After the two initial lanes are completed, there should be no difficulty in maintaining the rolling pattern. Rigid temperature control should be maintained during the rolling of all lanes, but especially the initial two lanes. All longitudinal joints will be hot joints formed by leaving a 3 inch edge of lane unrolled until the adjacent lane is placed. Thin layers of overlay on rigid pavement can be damaged by over-rolling with a tandem roller and the bond will be broken. On rigid pavements, experience has shown that greater density can be obtained on thick, 3 inch lifts than on thin 1 1/2 inch lifts due to the crushing of the aggregates during rolling operations.

All roller operators should be competent and be experienced since improper rolling resulting in a poor product requiring removal may cause delay in the scheduled opening of the runway. The Airport Director's representative should require prompt removal from the project any incompetent roller operator.

Construction of Transition.

At the end of each night's hot mix asphaltic concrete overlay operations, it will be necessary that a transition be constructed to provide a transition from the completion of the particular course of overlay to tie to the existing pavement.

* A transition is not required when the compacted thickness is 1-1/2" or less.

The construction of this transition is one of the most important features of the night's operation. Too steep a transition will cause possible structural damage to the operating aircraft or malfunction of the aircraft's instruments when the aircraft traverse the transition.

The transition should be constructed by the use of erected stringline; however, the asphalt spreader automatic controls should be cut-off at a depth of approximately 3/4" and then the material feather-edged by hand raking. The transition should be constructed as a permanent part of the overlay and need not be removed for the next night's operation when intermediate courses are involved. Leaving the transition in place for intermediate courses will save material and also save time by not having to remove and waste the transitional material. Aggregates raked out at the joints should be disposed of and not cast on the mat. The length of all transitions should be 10 ft. for every 1" depth of overlay measured longitudinally as shown on Figure 4.

* For the final surface course, the transition shall be cut back in all cases and the transition removed. In no event, should the transition be left in place and a "slip joint" constructed. This method can result in a rough joint with extensive raveling.

Infra-ray heaters should be required to heat the transition at the point where the overlay ties into the previously placed transition. Aggregates raked out at the joints to provide a smooth transition should be disposed.

The Contractor should develop expertise in starting overlay operations at the transition and should also develop expertise in raking aggregates out of the joint.

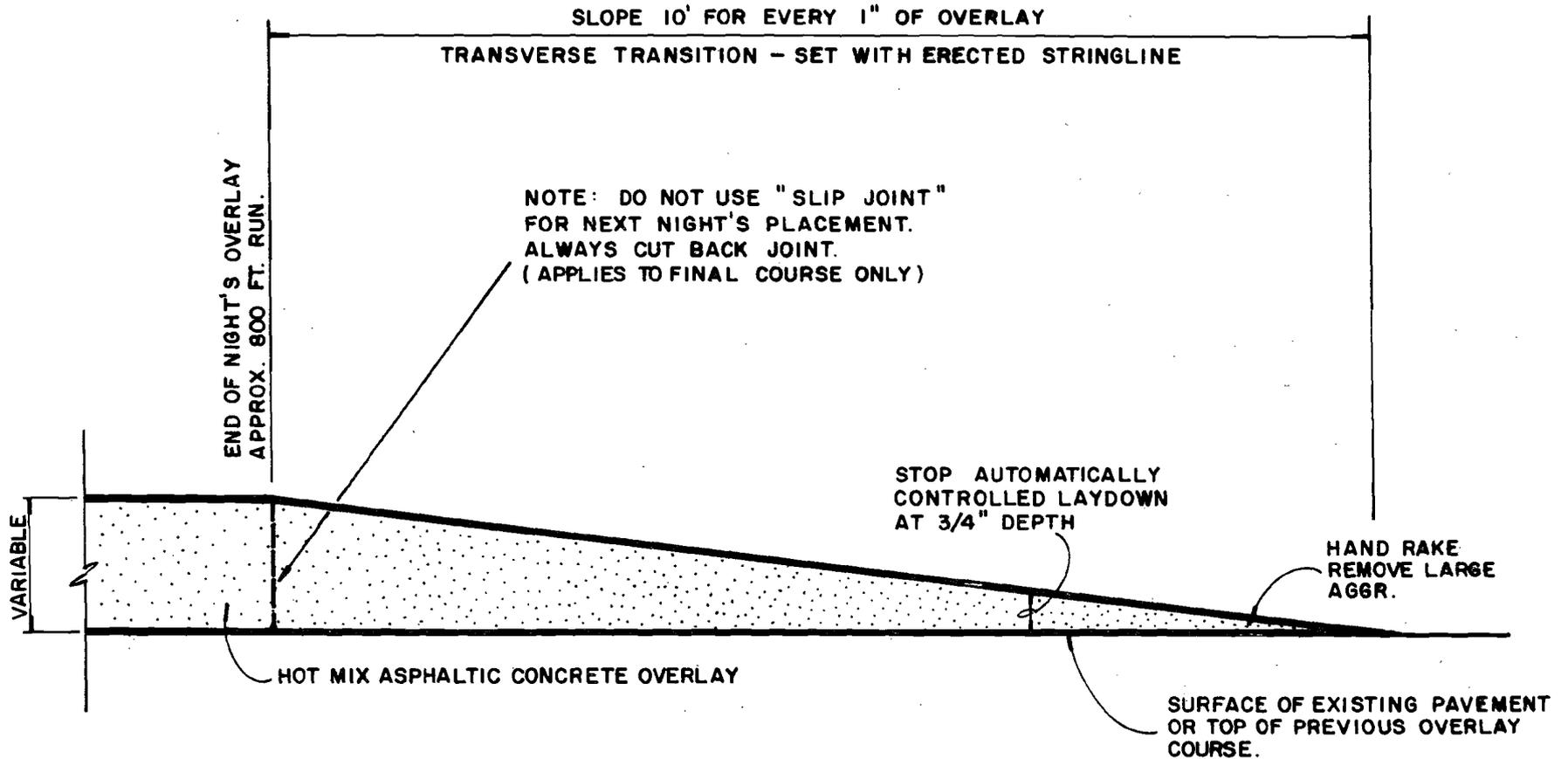


FIGURE 4 - TYPICAL SECTION OF TRANSVERSE TRANSITION
NOT TO SCALE

All joints at transitions should be straightedged in accordance with the specifications. The above described construction of transition is for 3/4" maximum sized aggregate. If larger sized aggregates are specified for the intermediate courses, the transition should be cut back and removed in all cases.

Painting Temporary Centerline Stripe and Numbers.

Prior to opening of the runway to aircraft traffic each morning, the Contractor should be required to paint a 12" wide white stripe down the center of the runway. The stripe should be for distance overlayed the previous night. If the overlay begins at runway ends, a temporary white number should be painted. The markings should be 6" wide stripes painted on 12" centers.

* Porous Friction Course.

A porous friction course should not be considered as the curing time will not permit immediate use of the runway.

* Grooving of Asphaltic Concrete Overlay.

In general, grooving of the completed hot mix asphaltic concrete overlay should not commence until at least 60 to 90 days. This curing time is required to prevent plastic flow of the mix. Some airports have grooved sooner as reported in the Runway Grooving paragraph of Appendix "A".

SECTION 4

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Results of a past study and follow-up study on the nighttime overlay operations at various airports indicate that it is entirely feasible to repair and overlay existing runways at night with hot mix asphaltic concrete. By using dense-graded hot mix asphaltic concrete overlay, aircraft can use a runway as soon as 1½ hours after the termination of actual asphalt placing. The quality of nighttime repairs and overlays obtained by using proper procedures, adequate inspection and testing of materials and with strict grade control can compare favorably with the quality of overlays constructed during daytime.

- * Results of the follow-up study indicate that construction practices associated with asphaltic concrete overlay such as slab replacement with precast slab, cold milling, retardation of reflective cracking with fabrics, heater scarifier, or rubber-asphalt surface treatments and sawing joints and sealing are feasible for nighttime construction.

When parallel runways exist at an airport, it is unwise to close one parallel runway for daytime repair and overlay work. The closing of one parallel runway will cause delays in aircraft traffic and inconvenience to the traveling public. Once the contractor is set up to repair and pave at nighttime and the paving crew is "broken in", there is no reason to perform any of the repair and overlay work in the daytime.

Comparison of specified surface tolerances and "as built" grade elevations show that "a good job can be performed at night". Thus, there is no justification to close a runway for daytime construction. The use of the accelerated construction procedure (continuous daytime and nighttime work) should be used only as a last resort. The loss of revenue to the airlines and the cities and the inconvenience to airline passengers for several days should discourage accelerated construction.

Any decision on the part of the airport authority to restrict repair and overlay work with asphaltic concrete to daytime construction is unwarranted.

*At present, there are no criteria except engineering judgement, to determine if the existing runway is smooth enough to be overlaid by using a traveling stringline in lieu of the erected stringline. The use of the traveling stringline for grade control will expedite construction and eliminate the cost of establishing the erected stringline.

Much of the specifications for asphaltic concrete overlays for daytime construction can be used in the specifications for nighttime work. However, the nighttime specifications should contain the requirements for the following additional items.

1. Working hours, suspension time, standby time, and downtime.
- *2. Penalties for not completing the work each night as specified.
3. Obstruction lighting
4. Construction lighting
5. Pavement repair (flexible)
6. Pavement repair (rigid)
7. Protection of existing airfield lighting fixtures
8. Asphalt plants
9. Asphalt spreading equipment and automatic grade control
10. Other items relating to grade control, compaction, aggregate selection, asphalt cement selection, tack coat selection and construction of transitions

All of the above items are outlined in Section 2 and Section 3 of this study and should be followed in the preparation of the technical specifications.

Recommendations

It is recommended in all cases that favorable consideration be given

to repairing and overlaying runways at nighttime with hot mix asphaltic concrete.

It is also recommended that no consideration be given to placing a porous asphalt friction course at nighttime. The open-graded mix requires more curing time than the 1½ hours allowed by nighttime construction before traffic. Inadequate curing can subject the porous course to shoving, rutting, and displacement by aircraft wheel loads. If desired, runway grooving at night in lieu of a porous friction course can be substituted to provide adequate skid resistance.

Development of criteria is recommended to determine the level of roughness or unevenness of existing runway surfaces at which the use of "traveling stringlines" is permitted.

APPENDIX A

LEVEL SURVEYS AND PLAN PREPARATION

General

The plans and specifications for nighttime pavement repair and overlay should be presented in such detail as to allow ready determination of the limits of pavement repair, finished grades and depth of overlay. The plans and specifications are to be used at night by the contractor and inspection personnel and should be clear and precise in every detail. A sample set of plans is included in Appendix "D" of this report.

Pavement Survey

It is important that the runway be surveyed and elevations determined so that a judgement based on variations in the elevations can be used to decide whether the hot mix asphaltic concrete can be placed with grade control provided by the use of a "traveling stringline" or by the "erected stringline" method. Decisions as to what method to use should be based on runway roughness studies. This item is very critical as the use of the ski will allow increased production during the nighttime construction period. Experience has shown that approximately 30 minutes to an hour is required to set the erected stringline for the first two passes of the asphalt spreader. Pavement survey should necessarily be run at night with artificial lighting as required to read the rod.

Establishment of Bench Marks by Rod and Level Survey

A complete system of bench marks should be set on the side of the runway to permit ready reference during cross-sectioning operations. The bench marks should be set at approximately 400' intervals. Normally, the bench marks are set on the concrete light pad corners. A square should be made on the light pad to indicate the exact location to set the rod. It is preferable to run the bench marks using a Philadelphia rod for best accuracy. Bench marks should not be run using a Lenker rod. The bench

mark survey should conform to the following error of closure:

Error of Closure = .0175

$\sqrt{\hspace{10em}}$ length of level run in miles

Cross-sections

Existing flexible pavement should be cross-sectioned on 12.5' center transversely and 25' center longitudinally. On rigid pavements, elevations should be taken on the joints. It will be found that transverse joint spacing for airport pavements is usually on 15, 20 or 25' centers. At the intersection of two joints, the elevations should be taken on the highest side of the joint. All elevations should be read to hundredths of a foot. In the level operations, the levelman should always tie into the bench marks that are located along the side of the runway at 400' intervals, as previously stated. If there is any difference in bench mark elevations, this difference should not be carried forward but the levelman should correct back to the elevation of the bench mark. In no case should these differences be accumulative.

For ease in recording elevations a plan of the runway should be prepared on the scale of 1" = 20' or 1" = 40', and the plan gridded in squares or rectangles with lines parallel to the centerline of the runway at 12.5' centers and transversely on 25' centers for flexible pavement and 15, 20, or 25' transversely for rigid pavement. The use of a Lenker rod will enable the levelman to record the elevation directly and eliminate the reduction of notes.

It will also be possible to survey the runway by the Laser profilometer system; however, this type survey will have to be performed at night in weather good enough to afford an unobstructed line of sight between the laser vehicle and the tracker vehicle.

Extreme care should be exercised in the level operations, since the elevations are to be used in determining the depth of asphalt overlay. Only in extreme cases will it be necessary for any construction levels to be run at night for the setting of the erected stringline. In the event an expansive soil exists or there is consolidation of the base material, and this should be determined in the soil investigation, the contractor should be required to verify all bench marks and to report to the representative of the Airport Director any variation over .03'.

Plotting Cross-section Data

Detailed cross-sections, for study purposes should be plotted from elevations taken from the grid sheet previously described in the subparagraph entitled "Cross-sections". The scale to be used for plotting the detailed cross-sections should be 1" = 0.40' vertical and 1" = 40' horizontal.

All grading plans should be drawn to a plan scale of 1" = 0.40', the same as the profile. This exaggerated scale is necessary due to the fact that frequently the vertical scale used is not exaggerated enough to show the transverse and longitudinal breaks in the runway pavement. By the use of vertical scale 1" = 0.40', it will be possible to actually read the finished grades direct without any computations.

The centerline runway profile, for study purposes, should also be plotted to the scale of 1" = 0.40' vertical and 1" = 40' horizontal. The use of this scale in plotting centerline runway profiles will allow for easy determination of the breaks and undulations in the existing pavements and will enable the runway gradients to be established more accurately.

On the same datum, the left and right edges of the runway should also be plotted, however the proper legend should be established to enable the designer to identify each edge. Any other profiles required should also be plotted on the same datum with an appropriate legend.

Determining Runway Gradient and Transverse Slopes

The new runway gradient should be determined from a study of the exaggerated profile. The depth of the overlay should be determined from detailed engineering studies which is beyond the scope of this report; however, non-destructive testing should be considered in evaluating the strength of the existing runway. Once the depth of the overlay is determined, the gradients should be set with points of intersection of the tangents at least 1,000 ft. apart. If possible the last 3,000' of the runway should have no break in grade. All grade changes in excess of 0.17 algebraic difference should be provided with vertical curves by use of the following formula:

$$\text{Length of vertical curve} = \frac{\text{Algebraic Difference}}{1667}$$

The transverse slopes of the runway should be studied and every attempt should be made to provide a transverse slope of 1.5 percent to secure adequate drainage. In no event should the transverse slope be less than 1.0 percent (except at intersecting runways).

Studies have indicated that approximately 95 percent of all take-offs and landings of jet transports can be accommodated on a strip approximately 80' wide. This area should be provided with a maximum 1.5 percent transverse slope without deviation. In no event shall runway grades be warped to meet taxiway grades as the reverse is required, i.e. taxiway grades should be warped to meet runway grades.

In instances where side crowned runways are encountered every attempt should be made to introduce third point or quarter point crown. This will improve the drainage of the runway and will facilitate drainage of the grooved runway if this operation is to be performed as a part of the contract.

The plans should include a typical section, or sections if required, which show the depth of the overlay and the number layers to be constructed. When the transverse slope of the runway is improved to provide a 1.5 percent center crown the top course of the pavement should follow the 1.5 percent slope whereas the other courses will vary depending on the depth of the overlay. The typical cross-section should identify the sequence of lane placing and the required number of paving lanes.

Finished Grade Data

After the finished grades and transverse slope of the runway are determined a tabulation of grades should be included in the plans for the contractor to use in bidding the project and for establishment of the erected stringline. An example of the tabulation is shown in sheets 12, 13 and 14 of the sample set of plans shown in Appendix "D". The tabulation of grades should be as follows:

1. Column showing existing runway elevation
2. Column showing finished overlay grade
3. Column showing total depth of overlay.

The grades should be shown longitudinally every 25' and transversely every 12.5'. It is considered that these grades will be a vital part of the contract plans as from the total depth of overlay the contractor can determine the depth of the overlay for each course.

The finished grades should also be shown in contour on the grading plan. The finished contours, as shown in the sample plans in Appendix "D", should be indicated by a heavy line for every 0.50' with the elevations of the contour shown in a box. The tenth contours should be indicated by a light line.

Pavement Repair, Flexible

The areas of flexible pavement removal and repair should be located and shown on the plans for bidding purposes. The appropriate drawing to show the location of pavement repair areas would be the 1" to 40' contour grading layout sheets. Prior to each night's construction, the Airport Director's representative should mark the areas to be removed that night. These areas should be marked in the presence of the project Superintendent or his authorized representative. Care should be taken not to remove more area than can be replaced before the time for the opening of the runway. The pavement to be removed should be sawed with approved equipment to sufficient depth to remove the failed areas without damage to the adjacent pavement. The plans should show a typical section which indicated the depth of the asphalt pavement, base and subbase as well as the classification and moisture

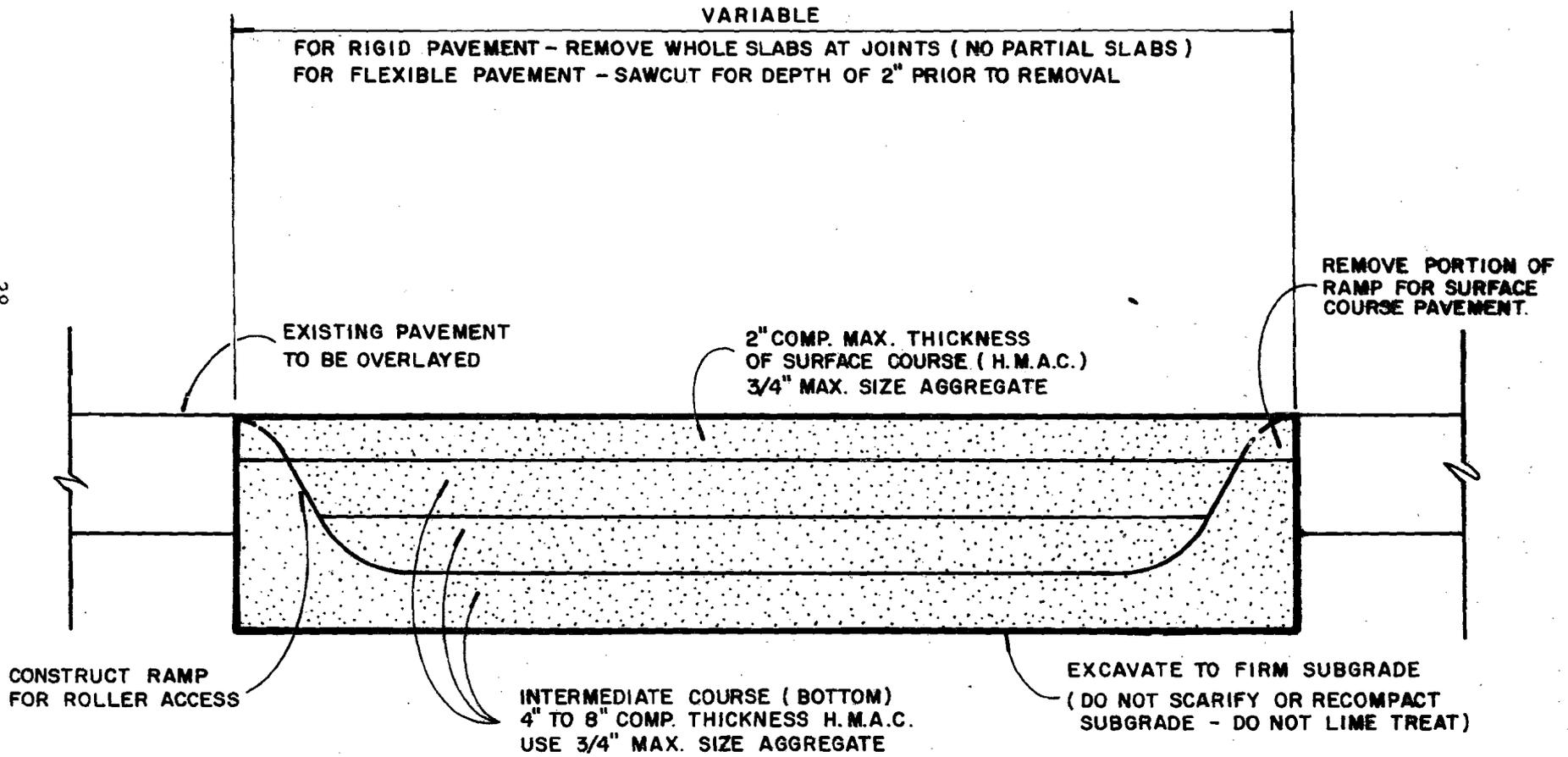


FIGURE 5 - TYPICAL PAVEMENT REPAIR SECTION

NOT TO SCALE

content of the underlying earth sub-grade.

The failed flexible pavement should be removed to the depth indicated on the plans or as directed until firm subgrade is reached. The actual depth of material to be removed is an on-the-spot decision that will have to be made by the Airport Director's representative together with the project Superintendent. It is considered that the nighttime construction period is too short to allow for the scarification and recompaction of the subgrade. The most expedient construction procedure is to use the hot mix asphaltic concrete mix for the full depth of the area to be repaired. The mix to be used for the pavement repair may be the same as the surface course mix and placed in 4" or 8" loose layers. (Care should be taken in highly plastic clay to place the bottom course a sufficient depth to bridge the area so that no pumping of the underlying clay subgrade will occur.) The compaction methods should be controlled so that the pumping of the underlying clay subgrade will be prevented. To prevent this condition, asphalt ramps should be constructed from the top of the pavement to the bottom of the repair area. The top of the asphalt ramp should be removed for the placement of the top layer to prevent a feather edge. Small repair areas not large enough to accommodate rollers should be compacted by manually operated vibrating rollers.

All pavement repair should be completed approximately 1 1/2 hours before the scheduled opening of the runway in order to allow the material to cool somewhat before being subjected to aircraft traffic. Past experience has shown that deep repair areas can be made with hot mix asphaltic concrete and successfully used by aircraft after the night's construction is completed. With the repairs made by the well-graded hot mix asphaltic concrete and the compaction methods hereinbefore specified there is no danger of displacement of the surface of the completed repair area. Figure 5 shows a typical section of pavement repair.

For pavement repairs at the ends of the runway and adjacent connecting taxiways consideration should be given to repairing those areas in the daytime hours by the use of a displaced threshold. This should only be after detailed studies are made of the runway length requirements which would allow the use of a displaced threshold. All standby equipment should be available during pavement repair operations.

Pavement Repair, Rigid.

The identification of areas of rigid pavement removal and repair for bidding purposes, the appropriate drawing to show the location of the repair and delineation of the repair areas each night for rigid pavement, are the same as for the flexible pavement described previously. For pavement removal complete slabs outlined by existing joints should be removed since experience has shown that the remaining portion of the rigid slab will eventually fail. PCC slabs usually are found to have the following joint pattern:

25' by 25'
15' by 12.5'
20' by 12.5'

The pavement should be removed by approved equipment and special care should be exercised not to damage the adjacent pavement. Care should be taken not to remove more slabs than can be replaced before the time of the opening of the runway. The plans should show a typical section which indicates the depth of the rigid pavement (including any reinforcing steel), sub-base as well as moisture content and in-place density of the underlying subgrade.

The failed PCC slabs should be removed as indicated on the plans or as directed by the Airport Director's representative. The sub-base and sub-grade should be removed until firm subgrade is reached. The actual depth of material to be removed is an on-the-spot decision that will have to be made by the Airport Director's representative in company with the Project Superintendent. It is considered that the nighttime construction period is too short to allow for the scarification and recompaction of the subgrade.

The most expedient construction procedure is to use the hot mix asphaltic concrete mix for the full depth of the area to be repaired as previously described for flexible pavement repairs. The compaction methods, completion of repairs, use of displaced threshold, and the availability of standby equipment should be the same as specified for the flexible pavement repair. Figure 5 shows a typical section of the pavement repair.

It is also possible to repair pavement failures by the use of precast slabs with load transfer devices. Slabs marked for removal should be measured exactly, allowing for a 1/2" gap around the outside. The slabs should be precast to the design pavement thickness and reinforced to resist lifting stresses. The slabs should be cast with holes as required to release water and air from underneath the slab after placement.

After removal of the existing pavement the subgrade should be excavated to an elevation of 6" lower than the bottom of the precast slab. This area should be backfilled with 6" of lean mix concrete and screeded off to grade. The precast slab should then be set on the lean mix concrete and then rolled with a 10 ton roller to level the slab and bring up about 1/2" of mortar up into each hole and around the perimeter.

After two or three nights, the 1/2" joint at the slab's four sides should be filled with polymer concrete and load transfer devices installed on approximately 2' centers around the perimeter of the slab. The load transfer devices should be installed in 6" cored holes and filled with polymer concrete flush with the surface of the pavement.

Porous Asphalt Friction Course

Porous asphalt friction courses should not be constructed during nighttime and immediately opened to aircraft traffic in the morning. The porous asphalt friction course is an open-graded mixture placed with a high bitumen content and will be subjected to dislodgement of aggregates and scuffing by aircraft tires if opened to aircraft traffic almost immediately after completion of rolling operations.

No vehicular traffic should be permitted on the porous asphalt friction course until it has cured for at least 12 hours. Completed areas should not be opened to aircraft traffic for seven days after construction. This requirement will rule out the use of porous asphalt friction course for nighttime overlay projects.

Runway Grooving.

In general, grooving of the completed hot mix asphaltic concrete overlay should not commence until at least 60 to 90 days after the completion of the asphaltic concrete. This curing period should prevent plastic flow of the mix. However, some airports have grooved much sooner than 60 to 90 days. At one airport, grooving was initiated approximately 24 hours after completion of overlaying with asphaltic concrete. The grooves performed satisfactorily. Other airports, grooving after much longer periods of curing, also reported satisfactory performances. Thus the required period before grooving asphaltic concrete has not been definitely established.

The recommended groove pattern is 1/4 inch by 1/4 inch with center spacing of from 1 1/8 inches to 2 inches. The grooving operations should be continuous for the complete length of the runway and sawed transverse (perpendicular to the runway center line). The grooving should terminate within 10 feet of the runway pavement edge to allow for the operation of the grooving equipment. It is important that the finished surface of the hot mix asphaltic concrete overlay be constructed in such a manner as not to have any nests of segregated or cast-on coarse aggregate. These areas of objectionable material will not hold up under grooving operations and the sawed aggregates will be subjected to dislodgement by jet aircraft blasts and wheels.

* Other details on grooving are found in FAA Advisory Circular AC No.150/5230-12 "Methods for the Design, Construction and Maintenance of Skid Resistant Airport Pavement Surfaces" dated June 30, 1975.

Protection of Existing Airport Lighting Fixtures

All existing airfield lighting fixtures along the edge of the runway and any in-runway lighting fixtures should be indicated on the drawing so

that the contractor will have knowledge of the fixtures requiring protection or adjustment. Any fixtures requiring adjustment in elevation should likewise be clearly indicated and details shown for adjustment. The specifications should include a paragraph which places a monetary penalty for any light so damaged. The phrase in the specifications should read substantially as follows:

"The contractor shall be responsible for the protection of existing lighting fixtures as indicated. The contractor shall pay the city the sum of \$200.00 for any fixture so damaged and requiring repair and/or replacement by the city airport maintenance personnel."

NOTE: The value of \$200.00 for the lighting fixture is for informational purposes only. The actual value of the lighting fixtures should be determined by the airport authority.

Pavement Surface Preparation

The plans and specifications should clearly indicate the requirements for pavement surface preparation. A thorough survey and inspection of the runway should be made by the Airport Director's representative prior to the preparation of the detailed plans and specifications. The requirements for pavement surface preparation are as follows:

Rigid Pavement

1. Spalls along pavement joints exceeding 1" in width and 4" in length should be removed by sawing the slab approximately 1" back of the spalled concrete and then removed to sufficient depth until sound concrete is reached. The area should be back filled with the same mixture as specified for hot mix asphaltic surface course or with fast setting commercial patching materials. The mixture should be thoroughly compacted with hand tampers or with hand operated vibrating mechanical tampers.
2. It is not considered necessary to remove rubber deposits from the runway provided the overlay thickness is two inches or greater. If it is desired to remove the rubber build-up, the material may be removed by high pressure water jets, chemicals, high velocity particle impact or mechanical grinding.

* Additional information on rubber removal from runway surfaces are provided in FAA Advisory Circular No. AC 150/5320-12.

3. Paint markings should be removed from the runway surfaces as the presence of the paint markings could interfere with the bonding of the overlay to the surface. The paint markings may be removed by high pressure water jets, high velocity particle impact or mechanical grinding.
4. There is no reason to remove existing joint sealing material from the joints in the rigid pavement unless the sealing material protrudes above the pavement surface and there is excess sealing material on the surface. If this condition exists, the sealant material should be removed by plowing or other methods to a depth of 1 1/2 inches and filled with a sand emulsion mixture. The excess sealing material should be removed from the surface of the pavement by blading or grinding or other approved methods.

Flexible Pavement

1. All failed areas in the pavement should be repaired as hereinbefore discussed in the paragraph entitled, "Pavement, Removal and Repair, Flexible".
2. Cracks in the pavement greater than 1/8 inches in width should be routed to a depth of 1 1/4 inches and width of 1/2 inch and filled with a mixture of sand emulsion.
3. If the existing asphalt pavement has an extensive crack pattern, consideration should be given to providing reflective crack prevention such as a single asphalt treatment, fabric or heater scarifying of the existing asphalt pavement. This should be immediately followed by the hot mix asphaltic concrete overlay the same night.
4. As previously mentioned, it is not considered necessary to remove rubber deposits from the runway provided the overlay thickness is 2 inches or greater. If it is desired to remove the rubber build-up, the material may be removed by high pressure water jets, chemicals, high velocity partial impact or mechanical grinding.
5. Paint markings should be removed from the runway surfaces as the presence of the paint markings could interfere with the bonding of the overlay to the surface. The paint markings may be removed by the same methods as specified for the removal of the rubber build-up.

Selection of Aggregate Gradation

The hot mix asphaltic concrete overlay specifications should provide for only one gradation for the entire depth of the overlay with no intermediate or binder course specified.

The recommended gradation for hot mix asphaltic concrete overlays where aircraft will use the runway within 2 hours after completion of rolling operations is as follows:

<u>Sieve Size</u>	<u>Percentage Passing by Weight</u>
3/4"	100
1/2"	89 ± 7
3/8"	82 ± 7
No. 4	66 ± 7
No. 8	53 ± 7
No. 16	41 ± 7
No. 30	31 ± 7
No. 50	21 ± 6
No. 100	13 ± 5
No. 200	4.5 ± 1.5

Tolerances should be as specified in FAA Specification P-401, "Bituminous Surface Course."

The deletion of the larger sizes of aggregates in the lower courses will prevent any emulsifying of the overlay when placed next to rigid or flexible pavement. Instances have been reported where the binder course using a lower bitumen content has emulsified and contributed to pavement failure.

In most instances where two gradations are specified, it has been found that contractors will bid the same for both the surface course mixture and for the intermediate or binder course mixture.

It is important that the correct specific gravity be used for aggregates used in the paving mix in order to determine the percent of voids total mix and percent voids filled with bitumen in the compacted specimens. Two different specific gravity determinations are provided, and the selection of the appropriate test procedure depends on the water absorption of each aggregate blend.

Apparent specific gravity of the fine and coarse aggregate should be used only with aggregate blends showing water absorption of less than 2.5 percent. The apparent specific gravity should be determined in accordance with ASTM designation for coarse aggregate, ASTM Specification C128 for fine aggregate, and ASTM Specification C188 or D854 (whichever is applicable) for mineral filler.

For aggregate blends showing water absorption to be 2.5 percent or greater the bulk-impregnated specific gravity method should be used. The bulk-impregnated specific gravity shown is to be determined in accordance with the procedure outlined in Method 105, MIL-STD-620A.

Selection of Asphalt Cement.

The selection of the grade of asphalt cement should be predicated on the grade of asphalt cement which is normally specified by the highway departments of the applicable state.

In setting up the specifications for the asphalt cement the exact specifications of the applicable state highway departments should be used.

As a comparison FAA Specification P-401 "Bituminous Surface Course" specifies asphalt cement to be grade 85-100, 120-150 conforming to AASHTO Specification M-20. In the state of Texas, the bitumen is specified, as in most states, by viscosity grade. For instance, grade 85-100 is classified as AC-10 and grade 120-150 is classified as AC-5. In hot climates, the use of AC-20 with a minimum penetration of 55 should be considered.

This method will secure the most favorable bid price for the asphalt cement and will be readily available. At central hot mix asphalt plants there will not be any complications in regards to the storage of the asphalt cement.

In most instances when specifications of asphalt cement are included in the contract specifications the Contractor actually uses the same material conforming to the applicable state highways departments specifications.

Selection of Tack Coat

Emulsified asphalt should always be used as a tack coat on the existing rigid or flexible pavement prior to overlay. The emulsified asphalt provides a more uniform coverage than cut-back asphalt which is difficult to apply at low rates of application.

It is important that the emulsified asphalt tack coat also be used between courses of the overlay unless the top course immediately follows the lower course. This is especially true when sandstone aggregate is encountered. Instances have been reported where shoving of the layers has occurred when the tack coat was omitted.

Caution should always be exercised to control the amount of emulsified asphalt placed. Normally 0.06 to 0.08 gallon of actual bitumen per square yard will be sufficient.

The designation of the grade of emulsified asphalt used should be the same as specified by the state highway departments in the locality where the overlay construction is to take place. There could be some resistance by Contractors to the use of emulsified asphalt since they may prefer to use cut-back asphalt. One of their objections could be that they do not have proper storage facilities, however, the use of emulsified asphalt for tack coat should be specified.

Asphalt Plants

Asphalt plants may be the batch, continuous or drum mixer type. For nighttime overlay construction, two asphalt plants should be operated simultaneously. It is preferable that the two plants be located adjacent to each other for ease of plant inspection, however this requirement is not mandatory.

The simultaneous operation of two asphalt plants will afford assurance of continued operation in the event of breakdown of one plant. Storage or surge bins for the hot asphalt mix should be used only on the approval of the project Superintendent. Bins should be designed and operated so as to prevent segregation of the mix. If the engineer in charge determines that segregation is occurring, he should prohibit the use of storage or surge bins. Hot asphalt mixtures should be kept in storage or surge bins for no longer than three hours.

Some state highway departments permit the contractor to operate the plant with all plant screens removed with the exception of the scalping screen provided all other requirements for batch and continuous mixing type plants are met. This method is acceptable provided the aggregates are uniform and the production is within the limits of the specification.

The contractor should make all facilities of the plant available and accessible to the plant inspector.

Hot Mix Asphalt Spreading Equipment and Automatic Grade Control

The hot mix asphalt spreading equipment should be self-powered and propelled and should be equipped with automatic screed controls to be used in connection with traveling stringline, erected stringline, or matching shoe. There are several types of traveling stringlines to use in overlay construction and several of these are explained below.

1. Ski - This type from 30' to 45' long lies on the pavement and straightens out depressions better than a wheeled device. The ski requires more mix to straighten out a depression but leaves a more level surface.
2. Wheeled device - This type from 30' to 45' long with two wheels on each and is best for rises. The sensor rides at the midpoint of the stringline thereby sensing the elevation of the front and rear wheels. This system allows a rise to be straightened out and results in a more level surface.
3. Footed frame - This type of traveling stringline consisting of metal feet attached to a metal frame is suitable for both rises and depressions. Each foot moves separately. The elevation

of the grade reference is changed to follow the average reading from all the feet. Therefore, one of the feet could fall into a depression while at the same time another one could be riding over a rise, the average of these high-lows would reflect itself in the grade reference and the mat would be laid accurately. It is important to note that when the sensor is used to sense from a traveling stringline, the stringline is usually as close to the paver as possible.

4. Erected stringline- The erected stringline is most effective where the runway pavement to be overlaid is in very poor condition gradewise. "Very poor condition" means long distances of depressions or rises that it would mean constant adjustments if a traveling stringline is used. The grade reference follower on the erected stringline will either be grid type or bar type. It is very important that the grade reference follower slide freely on the string. Tack coat on the feeder bar or string may cause some erratic sensing and operation. The joint matcher (6" shoe) should never be used on a stringline. The joint matcher exerts a two-pound reference surface and would cause extreme deflection in the erected stringline.

5. Shoe (Joint Matcher) - A shoe is a short metal grade reference that may be used alone or in conjunction with an erected or traveling stringline. When used in conjunction with one of the other types, the shoe is used to control the grade of the side opposite the stringline. The shoe is the most logical choice for use when the grade reference is another mat. The shoe should always be used to match joints on the final lift of a mat. Under certain circumstances the shoe can be used to match the first and/or intermediate layers of the overlay pavement.

Methods of Automatic Control

The automatic grade control system can be set up to provide grade control in several ways. For multiple lane paving during nighttime, two asphalt spreaders, both equipped with automatic grade control devices should be operated in echelon. For paving the initial lane when a traveling stringline is used, the first asphalt spreader should be equipped with sensors on both sides of the machine. After the first asphalt spreader has proceeded about 50 feet, the second paver should proceed using the matching shoe on the previously placed mat and a traveling stringline on the opposite side.

If the erected stringline method is used the first lane to be paved will require the asphalt paver to be equipped with sensors on both sides of the machine. After the first spreader has proceeded about 50'

the second paver should proceed as mentioned above and using a matching shoe on the previously placed mat with an erected stringline on the opposite side.

* Milling Operations Prior to Overlay

If the underlying pavement is asphaltic concrete of sufficient thickness, consideration should be given to milling pavement to grade prior to overlay. Controlled grades should be set for the operation of the milling machine. The milling machine normally will cut the pavement in a 9' - 2" wide pass. The depth of cut ranges from 1/4 inch to 4 inches, and the finished profile can be normally controlled to within 1/8" tolerance across the 9'-2" cutting mandrel of the machine. After the pavement is milled to grade, a uniform depth of overlay may be placed.

Milling of the existing asphalt pavement should not be considered if the resulting thickness of pavement including the overlay is less than the design thickness normally required for the surface course. It is also possible to mill concrete surfaces, however, the cost of milling might require that consideration be given to increasing the depth of the asphaltic concrete overlay instead.

* Retardation of Crack Reflection.

There are several methods normally used for the retardation of crack reflection of the underlying pavement through the overlay. Report No. FAA-RD-80-8 "Use of Fabrics and Other Measures for Retarding Reflective Cracking of Asphaltic Concrete Overlays" provides some information on the performance of various methods of retarding reflective cracking including fabrics, asphalt-rubber interlayers, bond breakers, stress relieving layers and asphalt mix additives. Any method used should be such that it can readily be incorporated into the nighttime overlay operation. Use of the various methods mentioned above does not seem to provide any insurmountable problem. However, no known method will completely prevent the formation of reflective cracks. Rubber-asphalt interlayers show promise in retarding reflection cracks. Also, indications are that fabrics provide some beneficial effects. For asphalt overlay on Portland cement concrete pavement, it is recommended that a 2" layer of asphalt overlay be placed prior to placing the fabric.

Heater scarifying is another method of deterring crack reflection prior to overlay. The existing asphalt pavement is normally heated and scarified to a depth approximately of 3/4 inches, then a rejuvenating agent is added, and the existing pavement is compacted prior to overlay. As an alternate method, the overlay can be added and compacted along with the scarified material.

Another method of treating reflective cracking in asphalt overlays is to recognize the fact that eventually cracks will develop in the overlay regardless of the method used to prevent this phenomenon. The basic concept is to saw a weakened plane in the asphalt overlay directly above the longitudinal and transverse joints in the concrete pavements being overlaid and to seal the saw cut. Based on the results of investigations of projects where this method has been used, it appears that the sawcut in the asphalt overlay should be within one-half inch of the joints in the existing pavement. The depth of sawcut should be determined by the depth of the overlay. The level of the joint sealant should be at least one quarter inch below the surface of the overlay.

APPENDIX B
QUALITY CONTROL OF CONSTRUCTION

Inspection and Testing of Materials

The construction of hot mix asphaltic concrete pavement at nighttime requires strict inspection of the operation and testing of materials. Normally on nighttime construction, two hot mix asphalt plants will be specified as well as two hot mix asphalt pavers. In the case of accelerated construction, it is possible that four hot mix asphalt plants will be in operation with three hot mix asphalt pavers.

The inspection and testing personnel for surveillance of the operation should be as follows:

- Engineer in Charge - 1
- Asphalt Placing Inspectors - 2
- Rolling Inspector - 1
- *Plant Inspector - 2

Daily inspection reports should be made by the engineer in charge. Reports should include location and description of work, results of surveillance and comments on specifications. Attached to the report should be a summary of the daily laboratory tests listing the following:

Asphalt content	Percent Voids
Stability	Percent Voids filled with Bitumen
Flow	Aggregate Gradation
Lab Density	Field Density

*If the two hot mix asphalt plants are not located in the immediate area, two plant inspectors should be required at each plant.

The quality control tests should be as follows:

Aggregate stockpile gradation

1. Required mix design preparation and as a check for variations in stockpile gradations.
2. Washed sieve analysis should be taken for each 1,000 tons of aggregate delivered to the job. The contractor should be required to ascertain the suitability of the aggregate before delivering on the job. It should not be the intent of the quality control organization to act as a testing laboratory for the contractor.

Hot Bin Samples

1. Hot bin gradation tests should be taken for every three days of production.
2. Tests should consist of one dry sieve analysis for each bin sample.
3. Resulting gradation should be paper blended to the feed percentages for use in the gradation unit. The blended mix should be plotted for conformance with the gradation as listed under "Selection of Aggregate Gradation" in Appendix "A".

Hot Mix Plant Samples

1. Hot mix plant samples should be taken and tested for each 500 tons of production or fraction thereof.
2. Tests should consist of three Marshall specimens and corresponding extraction tests. Reference should be made to truck samples to enable correlation with field density tests after placement.
3. Stability and flow should be determined in accordance with Chapter III, Manual Method of Mix Design of the Asphalt Institutes Manual Series No. 2 (MS-2) current edition and should meet the following requirements:

No. blows each side - 75
Stability (min) pounds - 1,800
Flow, hundredths of an inch - 8-16
Percent Voids Total Mix - 3-5
Percent Voids Filled with Bitumen - 70-80

4. Extraction tests and sieve analysis should be used to determine bitumen content and aggregate gradation compliance as follows:

Bitumen Content - 4-7%
Aggregate Gradation - as specified

Density Tests

Density tests should be taken for each 500 tons of hot mix asphaltic concrete placement or fraction thereof.

Tests should be taken on the section of pavement placed from the truck samples at the plant for stability, flow, etc.

One density sample should be taken on a longitudinal joint.

The location of sampling should be randomly selected by the use of random number tables as listed in the Asphalt Institute Manual Series No. 11 (MS-11) of January 1973.

Compaction of at least 98% of the density obtained in the laboratory should be required.

Temperature Tests

1. Each load on a truck should be checked for proper mix temperature of 325 degrees F. and recorded at the plant. Plant adjustments should be made to correct for variation.
2. Mixes produced in excess of 350 degrees F. should be rejected.
3. Mix temperatures at time of placement in the field should be taken and recorded for each truck.
4. Trials using sections should be run to determine the optimum temperatures for proper compaction of the mix. For example, the proper compaction temperatures which resulted from trials for an overlay of the primary runway at a Naval Air Station were as follows:

Breakdown Rolling - 280-290 degrees F.
Secondary Rolling - 260-275 degrees F.

The above temperatures were effective to the particular project which was located adjacent to the Atlantic Ocean where the hot mix asphaltic pavement cooled rapidly. No doubt proper compaction temperatures are affected by many factors. However, temperature requirements should be strictly enforced after being established by test section trials.

Checking Elevations of Completed Mat

Immediately after rolling operations for the night are completed, the contractor's field party should be required to determine the elevations of the completed mat. Elevations should be determined at 25' intervals and 12.5' or 25' transversely depending on the width of the asphalt spreader. These elevations should be reported to the project Superintendent each night so that any adjustments can be made if needed on the 3/16" per inch of rolldown. It is important that these elevations be taken the same night and not at the end of the job. They should be taken for each course so that the contractor will know at all times just how close the asphalt overlay is being placed to plan grade.

* This work should be performed by a field party regularly engaged in doing surveying work and not performed by a laborer used by the contractor on other duties.

Straightedge Requirements.

The finished surface of the final course of the hot mix asphaltic concrete overlay should be tested immediately after initial compaction. The finished surface should not vary more than 1/4" for the surface course when tested with a 16' straightedge.

The finished surface should be tested by the contractor and witnessed by the Airport Director's representative in both longitudinal and transverse direction. The contractor should be required to furnish a 16' rolling straightedge for testing purposes. In the longitudinal direction, one path in each lane should be selected for testing. In the transverse direction, random sites should be selected for testing.

Opening Runway to Aircraft Traffic

Prior to opening the runway, the Airport Director's representative should accompany the station manager of the various airlines to inspect the runway and to see that the transition is in place and that no FOD is on the runway. With the station manager's approval the Airport Director or his representative should then advise the FAA control tower operator that the runway may be opened.

It is mandatory that the runway be opened at the designated time without exception. This is important since airlines flight schedules are predicated on opening the runway at designated times. Instances have been reported where the contractor was allowed to continue asphalt placing operations after the target time for opening the runway due to the fact

that a parallel runway was available. This should not be permitted as there will be delays in airline operations and flight schedules.

Once the runway is opened to traffic, the only restrictive provision should be that locked wheel U-turns should not be permitted as the turning movement will mark the pavement with wheel marks.

APPENDIX C

AIRPORT STUDIES

SUMMARY ON NIGHTTIME PAVEMENT CONSTRUCTION PROCEDURES

at

COLUMBIA METROPOLITAN AIRPORT

WEST COLUMBIA, SOUTH CAROLINA

1. Airport Manager: Robert H. Waddle, Airport Executive Director
2. Facility Overlaid: Runway/Taxiway Strengthening Project and Associates Work, Columbia Metropolitan Airport, West Columbia, South Carolina, ADAP Project No. 6-45-0018-08.
 - a. Work dates: August 13, 1979 through August 19, 1979
 - b. Architect/Engineer: Wilbur Smith and Associates, Columbia, S. C.
3. Contractor: Sloan Construction Company
 - a. Experience of nighttime construction: The contractor has extensive experience in nighttime overlay construction.
 - b. Minority or other: No
4. Plans and Specifications: Information secured from South Carolina Asphalt Pavement Association and from Contractor.
5. Description of Overlay: Runway 11-29 was overlaid by the accelerated construction procedure which requires that the main runway be closed for one week from August 13, 1979 through August 19, 1979. During the construction period air-carried passengers were transported by bus to the Augusta, Georgia airport. The depth of the overlay was approximately 7 inches with the first course being placed 3 inches thick and the second and final course 2 inches thick each.
6. Transverse slope of runway increased: No
7. Hours worked, time of year: The Contractor worked around the clock from August 13, 1979 through August 19, 1979.
8. Construction planning for overlay-anticipated production:

The job was well planned by the Contractor in order to place 67,410 tons of hot mix asphaltic concrete pavement in 5 days.
9. Equipment:
 - a. Lighting: 28 portable light units, diesel powered with 30' telescoping metal poles featuring four 1,000 candlepower lights. Units were moved as needed by pick-up truck. Units were staggered every 500', i.e. there was a unit every 250' on opposite sides of runway.

- b. Laydown machine: One SA-150 Barber-Greene; One SA-145 Barber-Greene; One BSF-4 Cedarapids; Six BSF-2 Cedarapids.
- c. Plants: Two Cedarapids G-60, 250 and 300 TPH (batch); One Barber-Greene BE 101, 300 TPH (batch); One 88-28 drum plant, 200 TPH.
- d. Grade control: Dual control-used a 40'-ski and slope control on outside of first pass with joint matcher and ski bar on opposite side.
- e. Rollers: Vibratory: Three DA-50 Ingersoll-Rand; One Ferguson (SP-266) One Tempo. Static: Eight 8-12 ton tandem steel.

10. Quality Control: Asphalt Mix Requirements:

- a. Mix design: P-401 Bituminous Surface Course. The materials blend was as follows: 15% 6M stone; 30% 789 stone; 35% regular screenings and 20% sand. Based on peak of stability, peak of density and median of % total void curves; 5.5% AC-20 was used with a tolerance of ± 0.40 percent. The asphaltic concrete mixture was discharged from the plant at a temperature of 285°F, with a tolerance of $\pm 20^\circ\text{F}$.

b. Gradation:

Job Mix:	99.7	90.4	82.8	65.5	54.3	44.5	32.0	17.9	9.0	4.5
Job Specs:	<u>100</u>	<u>82</u>	<u>75</u>	<u>59</u>	<u>46</u>	<u>34</u>	<u>24</u>	<u>15</u>	<u>8</u>	<u>3</u>
		96	89	73	60	48	38	27	18	6

Suggested

Job Mix:	100	89	82	66	55	44	33	19	10	5
Tolerances:		± 7	± 7	± 7	± 4	± 4	± 4	± 4	± 2	± 2

- c. Stabilities: 1800 minimum and flow 8-16.
- d. Density: 98% of laboratory density.
- e. Voids: 3-5%.
- f. Voids filled: 70-80%.

- g. Field density: Averaged approximately 98% of laboratory density.

11. Grade Control Requirements:

- a. Ski: The Contractor used a 40 ft. ski and slope control on outside first pass with joint matcher and ski bar on opposite side.
- b. Level party check elevations after each course: Each course was not checked by field party.
- c. Straightedge: All straightedging was performed with a 16 ft. straightedge in accordance with FAA Specification P-401.

12. Lighting Fixtures (Adjustments):

- a. Edge lights: All edge lights were raised to grade.

13. Surface Preparation Prior to Overlay:

- a. Rubber removed: All rubber was removed.
- b. Paint removed: All paint was removed.
- c. Joint cleaning and filling with sand emulsion mixture: None.
- d. Excess sealer removal: None.
- e. "D" line cracking repair: None.
- f. Spall repair: None
- g. Slab removals and replacements: None.
- h. Other (mudjacking, asphalt underseal): None.
- i. Heater scarifying: None.
- j. Milling: None.
- k. Crack reflection preventive membrane: None.

14. Grooving of Asphalt: None.

15. Porous Friction Course: None

16. Miscellaneous Comments:

The Contractor production on this project was excellent with a total of 67,410 tons of hot mix asphaltic concrete placed during the five (5) day and night period. A tabulation of the contractors production is as follows:

COLUMBIA METRO AIRPORT ASPHALT PAVING TONNAGE

Date	Asphalt Plant #4 (tons)	Asphalt Plant #7 (tons)	Asphalt Plant #8 (tons)	M-C Asphalt Plant (tons)	Totals	
8/13 day	3053	2188	2700	DID NOT PRODUCE AT NIGHT		
8/13 night	740*	2530	1508			
8/14 day	2527	2594	2803			
8/14 night	3149	2524	2238			
8/15 day	2522	2753	1372*			
8/15 night	2236	2161	1944			
8/16 day	2620	2467	2487			
8/16 night	1803	1266**	2238			
8/17 day	1177*	2094	2008			
<hr/>						
Totals day	11899	12096	11370		7708	43073
Totals night	7928	8481	7928		-	24337

* Plant Breakdown - lost 4-8 hours

**Truck shortage due to taxiway work

Average daytime temperature 80°-85°

Average nighttime temperature 57°-68°

Mix temperature = 285°

SUMMARY OF NIGHTTIME PAVEMENT CONSTRUCTION PROCEDURES

at

MIAMI INTERNATIONAL AIRPORT

MIAMI, FLORIDA

1. Airport Manager: Richard Judy - Director of Aviation
Dade County Aviation Department
2. Facility Overlaid: Apron area adjacent to Concourses D, E, F, G, H, I, J. There were two projects involved constructed about one year apart.
 - a. Work dates: October 24, 1978 to March 20, 1979 - 29,136 tons placed. August 8, 1979 to September 27, 1979 - 16,789 tons placed.
 - b. Architect/Engineer: Howard, Needles, Tammen & Bergendoff.
 - c. Plans and specifications reviewed at: Contractor furnished information.
3. Contractor: General Asphalt Company, Inc., P. O. Box 52-2306, Miami, Florida 33166.
 - a. Minority or other: Yes.
 - b. Experience at nighttime construction: The work was awarded in two contracts. All asphalt base and leveling course was placed at night. The surface course was placed during the day. The General Asphalt Company was the first contractor to perform nighttime highway work in Florida.
4. Description of Overlay: An approximate 2" overlay was placed on the apron areas after leveling courses were placed. Texturizing of the apron was performed with a cold milling machine to improve the bond. Adjacent to concrete pavement the existing asphalt was milled to a depth of 2" to provide proper connection.
 - a. Transverse slope of runway increased: This project provided for overlay of apron only.
5. Contractor's organization: 120 employees, asphalt plant and silos, 48 asphalt haul trucks, 8 asphalt spreaders, 4 front end loaders, 14 rollers (different types), 4 maintainers, 1 chip spreader, 3 asphalt distributors and 1 water truck.

6. Hours worked, time of year: The contractor was allowed to work from 6:00 p.m. to 11:00 a.m. Actually the contractor worked from 6:00 p.m. to 6:00 a.m. On certain days the contractor was not allowed to work on account of heavy airplane traffic.
7. Cities' inspection of construction: HNTB provided full time resident inspection. The resident inspector was Mr. Joe Salazar. All survey work was performed by the contractor during the day by Post, Buckley, Schu & Jernigan, Inc.
8. Construction planning for overlay-anticipated production: The contractor planned to place approximately 800 tons per night which was the capacity of his silo. He could have placed more than anticipated if he had used the 800 tons from the silo plus 400 tons from plant at night. The work effort and production was limited by the availability of the aircraft parking gates. Some gates had to remain open each night.
9. Equipment:
 - a. Asphalt Spreader: Cedar Rapids Model BSF3R. Only one spreader used on project.
 - b. Plants: 10,000 ton H&B Batch Plant with 4 200-ton storage silos.
 - c. Grade Control: Erected stringline used for grade control with pins set every 25 ft. There were no problems with placing the erected stringline provided proper illumination was secured.
 - d. Rollers:
 1. Static rollers: None used.
 2. Vibratory rollers: Two vibratory rollers used on project - Dynapact CC50 and CC42.
 3. Lighting: Contractor provided six light towers with 4 1000-watt metal halide lights.
10. Quality Control: Asphalt Mix Requirements:
 - a. Mix design: The mix design conformed to FAA Specification P-401 for aircraft weighing over 60,000 pounds. The aggregate gradation was for 3/4" maximum size aggregates.

b. Gradations - Bituminous Surface Course P-401:

<u>Sieve Size</u>	<u>Designation</u>
3/4"	100
1/2"	82-96
3/8"	75-89
No. 4	59-73
No. 8	46-60
No. 16	34-48
No. 30	24-38
No. 50	15-27
No. 100	8-18
No. 200	3-6

- c. Extraction: Conformed to ASTM D 1559.
- d. Stabilities: Number of blows - 75, Stability 1800, flow 8-16.
- e. Density: 98% minimum of laboratory density.
- f. Voids: Percent air voids 3-5.
- g. Minimum voids in mineral aggregate - 14.
- h. Field density: 98-100% compaction required (Marshall). Minimum of four (4) Marshalls a.m. and p.m. made at plant. 6" cores made daily for density verification and correlation with nuclear gauge for field control.
- i. Number of laboratory technicians used at plant: Unknown - possibly two.
- j. Number of technicians used on laydown: One.
- k. Contractor provided his own Quality Control as a check on the Testing Laboratory: No.

11. Grade Control Requirements:

- a. Ski: Use 30 ft. ski on final two inch course of hot mix asphaltic concrete. This work was performed during daylight hours.
- b. Level party checked elevations after each course.
- c. Straightedge: On final course only - especially at junction with existing concrete pavement.

- d. Grade tolerance allowed by specification: 0.04 ft. plus or minus of plan grade according to specifications.
12. Lighting fixtures (adjustments):
- a. Centerline lights: None on apron, however manholes and catch basins were adjusted to grade during normal daylight working hours.
 - b. Edge lights: None.
13. Surface preparation prior to overlay:
- a. Rubber removed: No.
 - b. Paint removed: Texturizing removed paint markings.
 - c. Joint cleaning and filling with sand emulsion mixture:
Only joints between concrete and asphalt were sealed after overlay.
 - d. Excess sealer removal: None.
 - e. "D" line cracking repair: None.
 - f. Spall repair: None.
 - g. Slab removals and replacements: None.
 - h. Other (mudjacking, asphalt underseal): None.
 - i. Heater scarifying: None.
 - j. Milling was performed adjacent to Portland Cement Concrete Pavement to provide proper connection. The apron area was texturized to secure a superior bond. This method was very effective.
 - k. Crack reflection preventive membrane:
 - 1. Type of membrane used: All cracks in the existing pavement were covered with Petromat (Phillips 66 product) by placing strips of the fabric material over the cracks.

-END OF SUMMARY-

SUMMARY OF NIGHTTIME PAVEMENT CONSTRUCTION PROCEDURES

at

SHREVEPORT REGIONAL AIRPORT

SHREVEPORT, LOUISIANA

1. Airport Manager: John A. Alford
2. Facility: Overlaid: Runway 14-32 (7300' x 200).
 - a. Work dates - August 29, 1977 to April 24, 1978
 - b. Engineer - Aillet, Fenner, Jolly & McClelland, Inc., Shreveport, Louisiana
 - c. Plans and specifications reviewed at Engineer's office.
3. Contractor: Winford Company, Inc., Minden, Louisiana
 - a. Minority or other - None
 - b. Experience at nighttime construction - None
4. Description of Overlay: Second stage of runway strengthening for 727-200 type aircraft. The middle 100 ft. of the runway was constructed to full strength at 1.0% to 1.5% transverse slope. 50 feet on each edge was a transition at 2% maximum slope. Pavement thickness varied from 2 inches to approximately 12 inches. The maximum thickness occurred in a vertical curve which was lengthened. The number of layers was determined from the overall thickness. However, a uniform two inch layer was used for the final layer.
 - a. Transverse slope of runway increased - only at transition slopes.
5. Contractor's organization: Project superintendent, Wilford Shaw. Contractor was well organized with well disciplined and skilled personnel.
6. Hours worked, time of year: 10:45 p.m. to 6:45 a.m. from Monday to Saturday.
7. Cities' inspection of construction: Resident inspector Paul Bertrams and survey crew for layout furnished by the Engineer. Peabody Laboratories provided testing services. One laboratory technician was at the work site. Principal of the Engineers was on the job at initial start up and made periodic visits during construction.
8. Construction planning: Prebid and pre-construction conferences including airport management personnel.

9. Equipment:

- a. Asphalt Spreader - 25 ft. wide.
- b. Plants - Batch Plants remote from site, approximately 30 minutes haul time required, trucks were covered. 15 ton per truck capacity.
- c. Grade Control - Electronic sensors on laydown machine.
- d. Rollers
 - 1. Static rollers - Tandem and pneumatic.
 - 2. Vibratory rollers - Used for initial breakdown.
- e. Lighting - Portable - 4 1000 watt lights per unit.

10. Quality Control: Asphalt Mix Requirements.

- a. Mix design - P-201 Bituminous Base Course and P-401 Bituminous Surface Course.
- b. Gradations - Type "B" -P-401 & Type "C" -P-201

3/4"	100
1/2"	82-100
3/8"	68-90
No. 4	50-79
No. 10	36-67
No. 40	17-44
No. 80	9-29
No. 200	3-8
- c. Extraction: Marshall stability tests according to ASTM D 1559
- d. Stabilities - 1800 Min. and Flow 8-16 for P-201 and P-401.
- e. Density - 98% Min. of laboratory density for P-201 and P-401.
- f. Voids - 3 - 8% for P-201 and 3 - 5% for P-401.
- g. Voids filled - 60 to 70% for P-201 and 70 to 80% for P-401
- h. Field density - Averaged approximately 98%
- i. Number of laboratory technicians used at plant - One.

- j. Number of technicians used on laydown - One
- k. Quality Control - Contractor provided his own Quality Control as a check on the Testing Laboratory. A certified asphalt plant inspector was in charge of plant operations for the Contractor.

11. Grade Control Requirements:

- a. Ski - None
- b. Level party check elevations after each course - Initially and prior to succeeding layer: (1) Survey crew painted points at 25 ft. intervals on edges of lanes. (2) Elevation of each point determined. (3) Erected stringline height established for desired grade. Allowance for compacted thickness was made in the stringline by the survey Party Chief. Grades were tabulated for each layer or lift. (4) Pavement elevations were checked immediately after rolling by use of rod and level. (5) "As-built" grades determined by use of rod and level.
- c. Straightedge - 16 foot aluminum used for longitudinal and transverse checking.
- d. Grade tolerance allowed by specification - One quarter inch in 16 feet for surface smoothness tolerance. Neither thickness nor elevation tolerance specified.

12. Lighting Fixtures (Adjustments):

- a. Centerline lights - Centerline and touchdown lights were installed under separate contract during overlay operations. Light bases were set in existing pavement, bonded in place with high early concrete. A one inch steel cover plate was used to protect the light base until concrete set. The one inch thick plate was removed and replaced with 3/4" cover plate which fit the base. After paving operations were complete, pilot holes were drilled to locate the light bases and establish exact length of extension ring for each light since pavement thickness varied.
- b. Edge lights - High intensity edge lights were adjusted to conform to the new shoulder grades under separate contract.

13. Surface Preparation Prior to Overlay:

- a. Rubber removal - None
- b. Paint removal - None

- c. Joint cleaning and filling with sand emulsion mixture - None
- d. Excess sealer removal - None
- e. "D" line cracking repair - None
- f. Spall repair - None
- g. Slab removals and replacements - None
- h. Other (mudjacking, asphalt underseal) - None
- i. Heater scarifying - None
- j. Milling - None
- k. Crack reflection preventative membrane - None

14. Hot Mix Asphaltic Concrete Overlay Placing:

- a. Type of tack coat and rate of application - Emulsified asphalt- 0.05 to 0.20 gallons per square yard.
- b. Asphalt spreaders operating in echelon - None
- c. Width and depth of overlay for each lane - 25ft. wide - depth varied from 2 in. to 6 in. for each lane. Full width of 200 ft. placed each work period except 2 inch surface course was placed at a width of 100 feet for each work period to reduce the number of transverse joints.
- d. Length of overlay per night in feet - 200 ft. to 400 ft. - Variable P-201 @ 200 ft. width. 600 ft to 800 ft.- Nominal 2 in. P-201 @ 100 ft. width.
- e. Total amount of asphaltic concrete mixture placed per night - Variable P-201 - 600 to 1200 tons. Nominal 2in. P-401- 800 to 1300 tons.
- f. Amount of time between termination of asphalt spreading operations (not including rolling) and opening of runway to aircraft traffic - One hour.

15. Temporary Transition (at end of night's work):

- a. Length- 25 to 75 ft. with paper 3 feet wide to break bond at juncture with permanent pavement.
- b. Time for removal next night - Approximately 45 minutes.

- c. Procedure for removal - Blade grader and front end loader.
- d. Slip joint used - Transition pavement was removed in all cases.
- e. Transition mix- Used same mix as surface course. Raked out larger aggregate.

16. Climatic Conditions:

- a. Temperature - 40 to 80 degrees
- b. Wind - Variable
- c. Rainfall - Usual

17. Shoulder Construction:

- a. Type - Filled with borrow material for grade adjustments.

18. Grooving of Asphalt:

- a. Typical section of groove - Depth - Min. 3/16", Max. 5/16":
Width - Min. 3/16", Max. 5/16": Spacing (C.to C) Min. 1 3/8",
Max. 2".
- b. How long after overlay was grooving initiated? - Seven weeks.
- c. Test sections - 20 ft. long and 50 ft. wide.
- d. Any plastic flow of grooving? - None - some spalling.
- e. General acceptability for grooving - Grooving results were good.

19. Porous Friction Course:

- a. None

20. Miscellaneous Comments:

This being the second asphaltic concrete overlay constructed at Shreveport Regional Airport during the hours of darkness, the Project Engineers are convinced that nighttime construction is practical. By scheduling a uniform, two inch thick, final layer for a 100 foot width each work period, we were able to minimize transverse joints.

The contractor was conscientious and exhibited experience and good equipment. It goes without saying that nighttime overlay construction demands maximum cooperation and coordination with experienced people.

Worthy of note is that the engineering firm received two separate awards for this project:

1. From the Louisiana Asphalt Pavement Association Inc., for the best hot mix asphalt overlay in the state for the year 1978.
2. From the Shreveport Chapter of the Construction Specifications Institute for excellence in design and specifications.

- END OF SUMMARY -

SUMMARY OF NIGHTTIME PAVEMENT CONSTRUCTION PROCEDURES

at

SAN DIEGO INTERNATIONAL AIRPORT- LINDBERGH FIELD

SAN DIEGO CALIFORNIA.

1. Airport Manager: Administered by San Diego Unified Port District.
2. Facility Overlayed: Runway 9-27 and associated taxiways and portions of runway 13-31. Nighttime paving was considered necessary due to the fact that basically the airport has only runway 9-27 available for commercial airline operations.
 - a. Work dates- August-October 1980
 - b. Architect/Engineer - Reinard W. Bradley
Consulting Airport Engineer
2041 Hallmark Drive
Sacramento, Calif. 85825
 - c. Plans and Specifications reviewed at office of W.P. Wills, Consulting Engineers.
3. Contractor: Haehn Construction Company, San Diego, California (Primary Contractor) and Daley Construction Company, San Diego California (Paving Sub-contractor)
 - a. Minority or other. No.
4. Description of Overlay : After extensive pavement repairs the overlay was placed to a depth of approximately 8 inches. The asphalt was placed a maximum depth of 1 1/2 inches per lift so that no transition would be required.
 - a. Transverse slope of runway increased: Slope increased to 1 1/2 percent.
5. Contractor's Organization: The Contractor's organization was geared to nighttime operations and functioned very smoothly.
6. Hours Worked, Time of Year: The work period was from June through November 1980. For the first 150 calendar days the runway was closed from 11:45 p.m. until 7:30 a.m. Between 150 and 180 calendar

days the runway was closed from 11:45 PM to 6:30 AM with the exception that the Contractor was given 30 minutes to clear the runway to allow four aircraft to land. The liquidated damages were 1500 dollars per day. The Contractor was allowed a bonus of 1500 dollars per calendar day if the job was completed prior to the control date of 120 calendar days. If the Contractor failed to have the runway ready for aircraft to land at the specified time frame he was penalized \$500.00 for each 15 minute delay.

7. Cities' Inspection of Work: The Port Authority at San Diego provided their own inspection.
8. Construction Planning for Overlay - Anticipated Production: The Contractor planned to place approximately 800 feet of 1 1/2 inch hot mix asphaltic concrete for a 200 foot width. This production amounted to approximately 1520 tons per night.
9. Equipment:
 - a. Asphalt Spreader. The Contractor utilized one Blaw Knox PF180H paver for placing the hot mix asphaltic concrete pavement.
 - b. Grade Control was exercised by the laser beam which was set up at one end of the section with a target mounted on the paver. The laser level was model GS 945 manufactured by Spectra-Physics, Middlefield Road, Mountain View, California. The laser level emitted a rotating laser beam to form a plane.
 - c. Rollers.
 1. Static rollers: Hyster 12 ton (14 ton water filled) was used for final rolling.
 2. Vibratory rollers: Ingersoll Rand DA-50 (Dead weight of 18 tons) used for breakdown rolling.
 - d. Lighting. Six lights (Allmand Maxi-lites) were placed on the perimeter of the section being paved. A seventh Maxi-lite was mounted on the paver to light the immediate area. The rollers had their own headlights to provide increased visibility to the area.
10. Quality Control: Asphalt Mix Requirements FAA Specification P-401.
 - a. Mix Design. The mix design conformed to the requirements of FAA Specification P-401 Table 4 for the 1 inch maximum size aggregate when tested in accordance with ASTM Standard 136 (dry sieve only).

b. Gradations.

<u>Sieve Size</u>	<u>Percent by Weight Passing</u>
1"	100
3/4"	84- 100
1/2"	74- 88
3/8"	68- 82
No. 4	53- 67
No. 8	40- 54
No.16	30- 44
No.30	20- 34
No.50	13- 25
No.100	9- 17
No.200	3- 6
Bitumen	4.5-7.0

c. Test Properties. The job mix formula required the following test properties.

Number of Blows	75
Stability Minimum Pounds	2000
Flow 0.01 inch	8-18
Percent Air Voids	3-5
Percent Voids in Mineral Aggregate	13

d. Densities. For full payment the specifications required that the Contractor compact the asphaltic concrete to at least 98% of laboratory density. For compaction less than 98% the following adjusted pay schedule was used.

<u>Relative Marshall Compaction Density 75- Blow Test</u>	<u>Payment Made to Contractor Percent of Unit Price Bid</u>
98 +	100%
97 to 97.9	95%
96 to 96.9	90%
95 to 95.9	75%
Less than 95	Remove

f. Number of Laboratory Technicians Used at Plant. Unknown- perhaps two technicians were used.

g. Number of Technicians Used on Laydown. One inspector observed asphalt placing operations.

h. Contractor provided his own quality control as a check on the Testing Laboratory. The Contractor provided American Engineering Laboratories, San Diego, CA. to monitor the testing of the Port Authority requirements.

11. Grade Control Requirements.

a. Ski. The Blaw Knox paving machine was specified to be equipped with a leveling ski not less than 20 feet in length to be operated in connection with automatic grade control. Actually the Contractor provided laser grade control as previously mentioned.

b. Level Party Check Elevations After Each Course. The Contractor provided field parties to check elevations after each 1 1/2 inch course was placed.

c. Straightedge. The specifications required that the finished surface not vary more than 1/4 inch for the surface course when tested with a 16 foot straightedge.

d. Grade Tolerance Allowed by Specification. The grade tolerance was 1/4 inch for the finished surface. If the final grade was over 1/4 inch under specified final grade the asphalt concrete pavement was required to be removed. Any material placed over 1/4 inch high would not be measured and paid for.

12. Pavement Repair.

a. Existing pavement - Lindbergh Field 9400 ft. long runway is non-reinforced Portland cement concrete, 12 inches thick with slab dimensions of 12 1/2 ft. by 15 ft. The first signs of failure in the 200 ft. wide runway were small longitudinal cracks that progressively deteriorated the pavement. Approximately three years prior to 1980 there were approximately 50 cracked slabs and at the start of pavement repair operations there were approximately 300.

b. Pavement Investigations. The cracked slabs were due to lack of load transfer from one slab to another. The slabs were moving under loads thus causing cracking and spalling. To determine the problem a slab seated deflection beam was used that had an electronic gauge placed on each side of the joint in question. A four-wheeled earth moving rig with a 55,000 lb load per wheel was run across the joint and the deflection measured. The Engineers ran tests at one

per minute, measuring every joint in a 7500 ft. center portion of the runway. These tests showed slabs that had voids under them, and the size of the voids. The tests also indicated which slabs had no load transfer and were moving.

c. New Load Transfer Devices. Tests indicated that approximately 15% of the slabs needed load transfer repair. The method used by the Engineer to provide load transfer consisted of 19,000 holes, 6 and 8 inches in diameter to a depth of 12 inches. In these cored holes was placed a patented load transfer device and the hole then filled with polymer concrete. This proved to be a very acceptable means of providing load transfer. After the load transfer devices were installed, deflection measurements were as low as 0.002".

d. Repairing Random Cracks. Approximately 7000 linear feet of random cracks were repaired by the "stitching method." This method involved drilling 4 inch diameter holes 12 inches deep on one foot centers along cracks and filling with polymer concrete. The cracks were then grooved out 2 inches deep and 1/2 inch wide and filled with polymer concrete to seal the joint.

e. Repair of Failed Slabs. The plans indicated approximately 116 broken slabs to be removed. Due to the fact that poured concrete would take two weeks to cure it was necessary than another method be used to replace the failed slabs.

Pre-cast slabs, tied down with the patented load transfer device were utilized for rapid repair. Slabs marked for removal were carefully measured, allowing for 1/2 inch gap around the outside and a 12 inch replacement slab was pre-cast to the exact dimensions for each individual slab. The slab was reinforced to resist a lifting stress and cast with nine holes in order to release water and air from underneath the slab after placement.

The slab to be removed was sawed full depth along the perimeter and then broken up with a pavement breaker. The area below the removed slab was excavated to a depth of 6 inches. A lean mix concrete base was then placed and screeded off to grade. The pre-cast slab was then placed, immediately, directly on top of the lean mix concrete and rolled with a ten-ton roller to level the slab. Two nights later, the 1/2 inch joint was filled with polymer concrete and load transfer devices installed in 6 inch diameter cored holes spaced on 2 ft. centers around the perimeter of the slab. After installation of the load transfer devices the holes were filled with polymer.

13. Lighting Fixtures (Adjustments):

a. Centerline Lights. A new runway centerline and touchdown zone lighting system was installed in accordance with FAA Advisory Circular 150/5340-4C.

b. Edge Lights. A new high intensity runway light was installed on runway 9-27 in accordance with FAA Advisory Circular 150/5340 - 24. Existing taxiway edge lights were adjusted to the new grade.

14. Rubber and Paint Removal:

The specifications required that 85% of each square foot of pavement surface area be cleaned of all rubber deposits and paint.

15. Milling:

None.

16. Crack Reflection Membrane:

None.

17. Hot Mix Asphaltic Concrete Overlay Placing:

a. Asphalt Spreaders Operating in Echelon. Only one Blaw-Knox PF 180H paver was used in placing the hot mix asphaltic concrete pavement.

b. Width and Depth of Overlay for Each Lane. The depth of the overlay was confined to 1 1/2 inches in order that a transition would not have to be constructed. The width of placement was 12 1/2 feet.

c. Length of Overlay Per Night in Feet. The length of overlay per night was approximately 800 feet.

d. Total Amount of Asphaltic Concrete Mixture Placed Per Night. Approximately 1520 tons were placed per night.

18. Temporary Transition (at end of night's work):

None. The hot mix asphaltic concrete pavement was placed to a maximum depth of 1 1/2 inches in order that a transition would not be required, both longitudinally and transversely.

19. Joint Sealant.

Two joint sealants were used on the project. Defective sealant in the Portland cement concrete pavement was removed and replaced with joint sealant conforming to Federal Specification SS-S-1401. Joint sealant material in order to control reflective cracking through the bituminous surface course overlay, joints were sawed in the finished

pavement to match the pattern existing in the underlying PCC pavement. The joint sealant was composed of asphalt and a vulcanized rubber material.

20. Grooving of Asphalt:

- a. Typical section of groove. Grooves were sawed in the completed bituminous surface course transversely 1/8" x 1/8" at approximately 2" center to center spacing.
- b. How Long After Overlay Was Grooving Initiated? The overlay was grooved 30 days after placement.
- c. Test Sections: No test sections made.
- d. Any Plastic Flow of Grooving? No.
- e. General Acceptability of Grooving. Good.

21. Conclusions:

The project at Lindberg Field included the following new nighttime construction procedures using asphaltic concrete.

- a. Replacement of failed slabs with precast concrete reinforced slabs and installation of load transfer devices. The use of polymer concrete for filling core holes.
- b. Use of laser beam for screed control of the asphalt spreading machine.
- c. Elimination of transitions by limiting the depth of overlay to 1 1/2 inch maximum thickness after compaction.

SUMMARY OF NIGHTTIME PAVEMENT CONSTRUCTION PROCEDURES

at

ADAMS FIELD

LITTLE ROCK, ARKANSAS

1. Airport Manager: R. M. Crisp, Sr.
2. Facility Overlayed: ADAP Project 8-05-0035-07. Strengthen runway 4-22 and related electrical work.
 - a. Work dates: First asphalt placed September 9, 1976. Work completed on November 26, 1976.
 - b. Architect/Engineer: Garver & Garver, Inc., Little Rock, Arkansas, Roy Grimes, Principal.
 - c. Plans and specifications reviewed at office of Garver & Garver.
3. Contractor: Ben Hogan Company, Little Rock, Arkansas.
 - a. Minority or other: Not a minority contractor.
 - b. Experience at nighttime construction: Contractor has previous experience in nighttime pavement overlays.
4. Description of Overlay: 2" asphaltic concrete surface course and approximately 4" asphalt levelling course.
 - a. Transverse slope of runway increased to 1.5%.
5. Contractor's organization: The contractor was well organized to perform nighttime overlay operations.
6. Hours worked, time of year: The time worked was 11:30 P.M. to 6:30 A.M. The paving was accomplished during the months of September, October and November.
7. Cities' inspection of construction:

Garver & Garver, Inc. Consulting Engineers inspected the project.
8. Construction planning for overlay-anticipated production:

The proposed work was planned as follows:

- Phase I 827' displaced threshold to Runway 22.
- Phase II Repair runway between Runway 22 and end.
- Phase III 500' displaced threshold for Runway 4.
- Phase IV Repair runway between displaced thresholds.
- Phase V Bituminous levelling and surface course.

9. Equipment:

- a. Asphalt Spreader: Laydown machine - 12.5 ft. wide asphalt spreader with electronic controls.
- b. Plants: Batch type plant.
- c. Grade Control: For the full length and width of the runway including intersections the finished grades of the levelling course was controlled by instrument readings. The existing surface was marked off at 25 ft. intervals both longitudinally and transversely. Elevations were taken at all points. The entire levelling course and surface courses were controlled by electronic grade controls. The erected stringline for the levelling course was placed with the grade set at predetermined elevations which included the asphaltic fill plus rolldown.
- d. Rollers:
 - 1. Static rollers: Used tandem roller for breakdown rolling. Heavy duty pneumatic roller used for rolling with tandem used for final rolling.
 - 2. Vibratory rollers: None used.
- e. Lighting: Lights provided on all rollers and asphalt spreaders. Contractor utilized two mobile lighting units

10. Quality Control: Asphalt Mix Requirements

- a. Mix design: FAA Specification P-401 and P-201 Gradation A
- b. Gradations: P-201 Gradation "A"

P-201

<u>Sieve Size</u>	<u>Percent Passing</u>	
	<u>Job Mix</u>	<u>Gradation A</u>
1-1/4"	100	100
1"	97	86-100
3/4"	80.6	68-92
1/2"	71.7	55-84
3/8"	62.6	46-76
No. 4	44.8	32-64
No. 10	30.4	20-50
No. 40	20.9	8-30
No. 80	10.0	4-19
No. 200	5.6	3-8

P-401

<u>Sieve Size</u>	<u>Percent Passing</u>		
	<u>Job Mix</u>	<u>Narrow Spec.</u>	<u>Wide Spec.</u>
3/4"	100	100	100
1/2"	95.3	88.3-100	82-100
3/8"	82.5	75.5-81.5	68-90
No. 4	60.1	53.1-67.1	50-79
No. 10	44.4	40.4-48.4	36-67
No. 40	27.3	23.3-31.3	17-44
No. 80	14.4	10.4-18.4	9-29
No. 200	5.9	3.9-7.9	3-8

- d. Stabilities: P-201 Stability 1964 Flow 10.8
P-401 Stability 1986 Flow 10.5
- e. Density: 98% of laboratory density.
- f. Percent of Voids: P-201 6.5%
P-401 3.7%
- g. Voids filled: P-201 66.3%
P-401 73.4%
- h. Field density: Averaged approximately 98% of laboratory density.
- i. Number of laboratory technicians used at plant: Unknown - probably two.
- j. Number of technicians used on laydown: One.
- k. Contractor provided his own Quality Control as a check on the testing laboratory: No.

11. Grade Control Requirements:

- a. Ski: Erected stringline used.
- b. Level party check elevations after each course: Field party checked grades of levelling course and final surface course.
- c. Straightedge: Finished surface course checked with 16 ft. straightedge with 1/4" tolerance.
- d. Grade tolerance allowed by specification: 0.03 ft. from plan grade.

12. Lighting fixtures (adjustments):

- a. Centerline lights: None
- b. Edge lights: Adjusted to new grade.

13. Surface preparation prior to overlay:

- a. Rubber removed: Yes.
- b. Paint removed: Yes.
- c. Joint cleaning and filling with sand emulsion mixture: None.

- d. Excess sealer removal: None.
 - e. "D" line cracking repair: None.
 - f. Spall repair: None.
 - g. Slab removals and replacements: None.
 - h. Other (mudjacking, asphalt underseal): None.
 - i. Heater scarifying: None.
 - j. Failed bituminous pavement on concrete base was generally removed to a depth of 12" and replaced with hot mix asphaltic concrete base P-201. On bituminous areas with crushed stone base the pavement was removed and replaced to a depth of 20".
 - k. Milling: None.
 - l. Crack reflection preventive membrane: None.
14. Hot mix asphaltic concrete overlay placing:
- a. Asphalt spreaders operating in echelon: Single asphalt spreader used. 12.5 wide placing.
 - b. Width and depth of overlay for each lane: None.
 - c. Length of overlay per night in feet: Approximately 600 ft. full width of runway.
15. Temporary transition (at end of night's work):
- a. Length: Approximately 30 ft.
 - b. Time for removal next night: Approximately 30 minutes.
 - c. Procedure for removal: Blade grader.
 - d. Slip joint used: Transition cut back.
 - e. Transition mix: None.
16. Grooving of asphalt:
- a. Typical section of groove: The groove was 1/4" by 1/4" with center to center spacing of 1-1/2".

- b. How long after overlay was grooving initiated? February 15, 1977.
- c. Test sections: 20 ft. long by 50 ft. wide (111 sq. yds.)
- d. Any plastic flow of grooving? No plastic flow.
- e. General acceptability of grooving: Grooving very acceptable.

19. Porous friction course:

Porous friction course was originally planned for the project, however the porous friction course like all other items would have to be performed at night between 11:30 P.M. and 6:30 A.M. It was determined that a 24 hour curing period is needed for the PFC before aircraft traffic is allowed to use the pavement. The only way to satisfactorily test the PFC would be to close the runway for a week, thus eliminating air carrier service for that period. Grooving was substituted for the originally planned porous friction course since the grooving could be performed at night with no interference with air carrier operations.

20. Texturization of runway in lieu of grooving: None

21. Miscellaneous Comments:

The contractor was paid suspension time if all work was called off by 8:00 P.M.

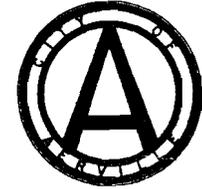
On standby time, the contractor was paid by the hour to "stand by" from 11:30 P.M. to 1:30 A.M. After that, the work was called off.

Close grade control was achieved on this project by the airport consulting engineers, Garver & Garver, Inc.

APPENDIX D.

SAMPLE PLANS

CITY OF AERVILLE
DEPARTMENT OF AVIATION



AERVILLE MUNICIPAL AIRPORT

OVERLAY RUNWAY 8 - 26

FAA ADAP PROJECT NO 1-00-0000-01

240 TEMPLATE
PEN 3

RECOMMENDED FOR APPROVAL:

175 TEMPLATE
PEN 1

FOR W.P.WILLS CONSULTING ENGINEERS

100 TEMPLATE
PEN 00

THIS THE _____ DAY OF _____, 1982, A.D.

W. P. WILLS, P.E.
PRINCIPAL

300 TEMPLATE
PEN 4

APPROVED:

FOR THE CITY OF AERVILLE

THIS THE _____ DAY OF _____, 1982, A.D.

DIRECTOR OF AVIATION

THIS THE _____ DAY OF _____, 1982, A.D.

DIRECTOR OF PUBLIC WORKS

APPROVED BY THE CITY COUNCIL

THIS THE _____ DAY OF _____, 1982, A.D.

8:05 TO BE RECEIVED UNTIL 1:30 P.M. ON THE _____ DAY

OF _____, 1982, A.D.

CITY SECRETARY

PREPARED BY



W. P. WILLS

CONSULTING ENGINEERS

SUITE 8-103 LOVE FIELD TERMINAL BLDG

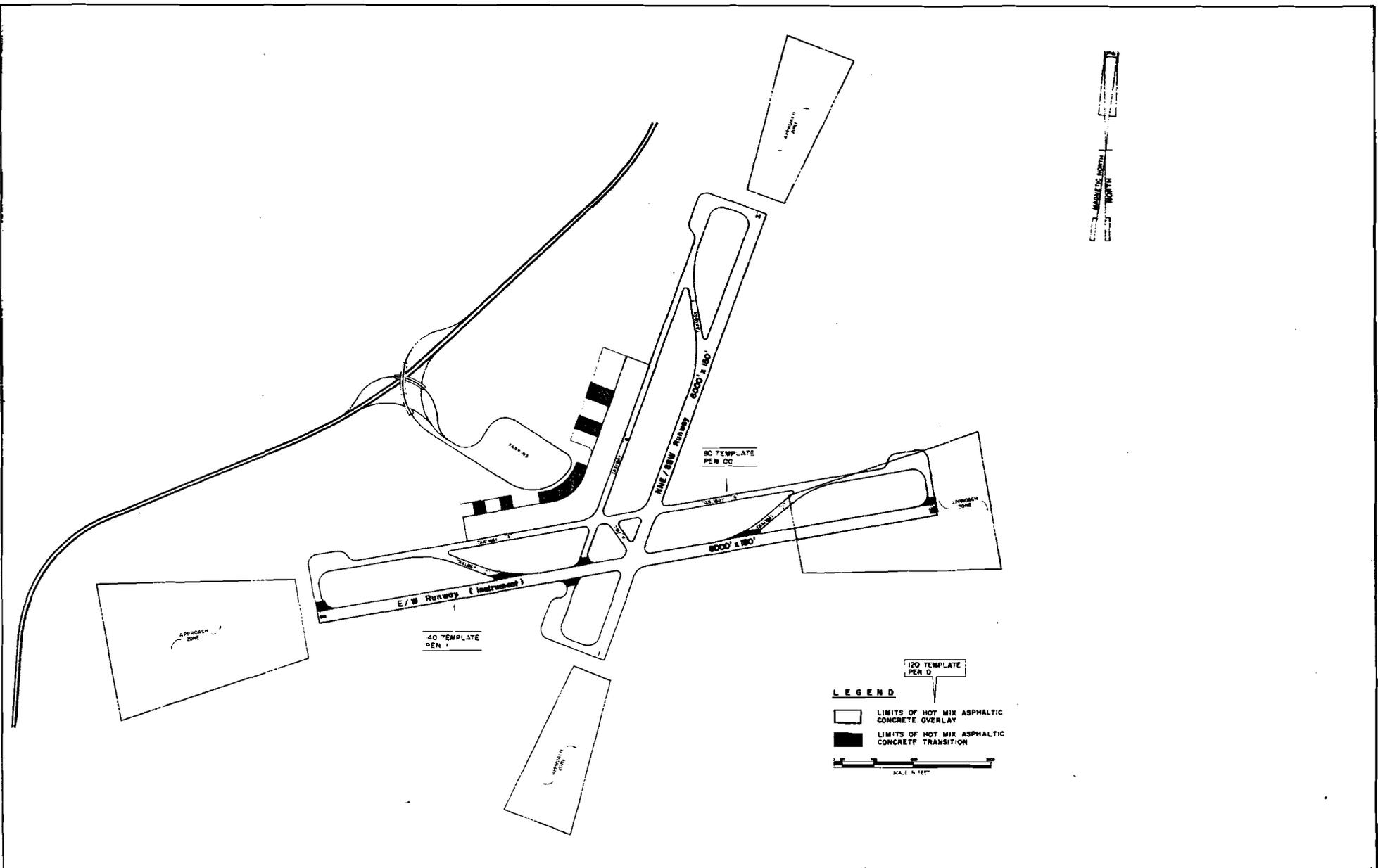
DALLAS, TEXAS 75235

(214) 350-3648

DRAWING NO.
180 D - 01

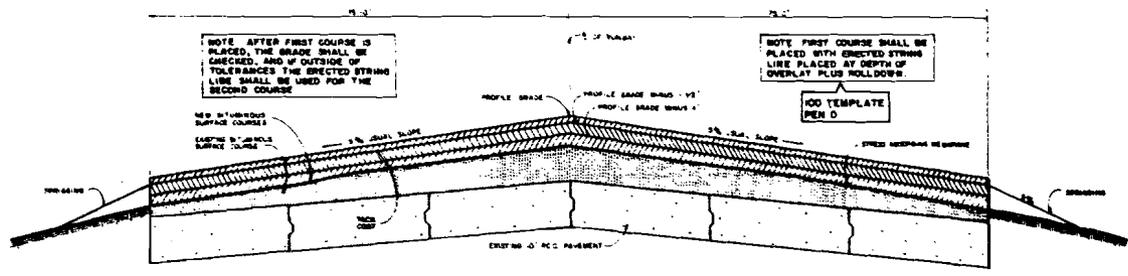


APPENDIX "D"

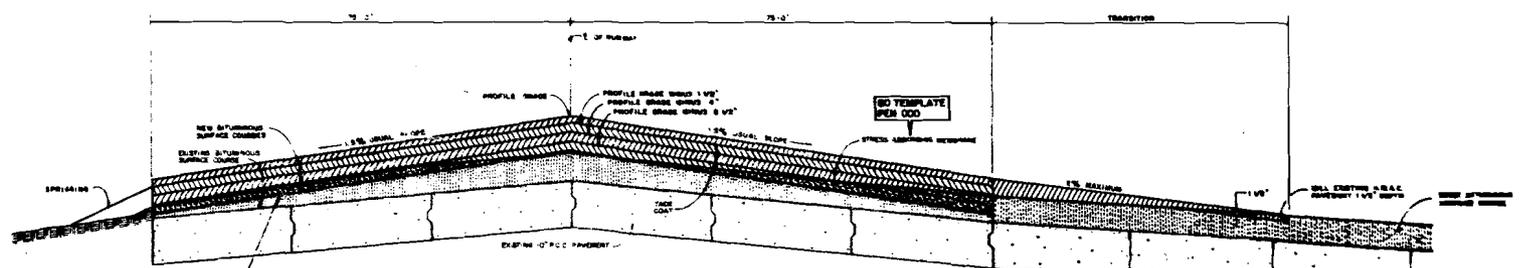


DESIGNED DRAWN CHECKED	 W. P. WILLS CONSULTING ENGINEERS DALLAS, TEXAS	CITY OF AERVILLE DEPARTMENT OF AVIATION AERVILLE MUNICIPAL AIRPORT	APPROVAL RECOMMENDED	AERVILLE MUNICIPAL AIRPORT OVERLAY RUNWAY 8-26	DATE JULY, 1982
			APPROVED		PROJECT LAYOUT PLAN
REVISIONS NO. BY DESCRIPTION OF REVISIONS	DATE REV.		DIRECTOR OF PUBLIC WORKS		
			DIRECTOR OF AVIATION		

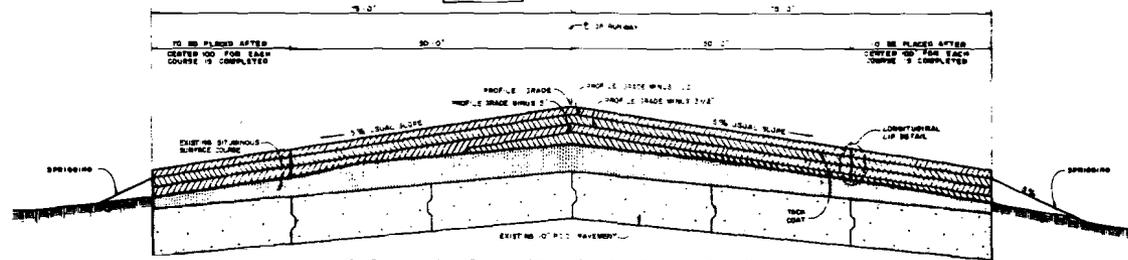
GENERAL NOTES
 ALL NEW AND ASPHALTIC CONCRETE OVERLAY COURSES SHALL CONFORM TO AASHTO SPECIFICATION P-401, TABLE 4, 3/4" MAXIMUM SIZE AGGREGATE



TYPICAL OVERLAY SECTION WITH FULL WIDTH PAVEMENT



TYPICAL OVERLAY SECTION WITH EXISTING H.M.A.C. SURFACE MILLED TO 1.5% SLOPE



TYPICAL OVERLAY SECTION WITH CENTER 100 FT. OF OVERLAY CONSTRUCTED FIRST



LONGITUDINAL LIP DETAIL

- NOTES:**
1. NO LONGITUDINAL LIP AT THE CENTER OF THE RUNWAY PROVIDE A SMOOTH TAPER OF 1/4" PER FOOT (1" OF DISTANCE) IN LEVEL IN THE CENTER, NO MORE THAN 2" MAXIMUM DIFFERENCE IN LEVEL OF 1/4" OF 1/4" IF GREATER, A TAPER OF 1" PER FOOT 1" DIFFERENCE IN LEVEL AS ABOVE IS REQUIRED
 2. TRANSVERSE LIP SHALL BE TAPERED WITH A SLOPE OF 1" PER EVERY 1" DIFFERENCE IN LEVEL



DESIGNED BY	DESCRIPTION OF REVISIONS	DATE REV.

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 CONSULTING ENGINEERS
 DALLAS, TEXAS

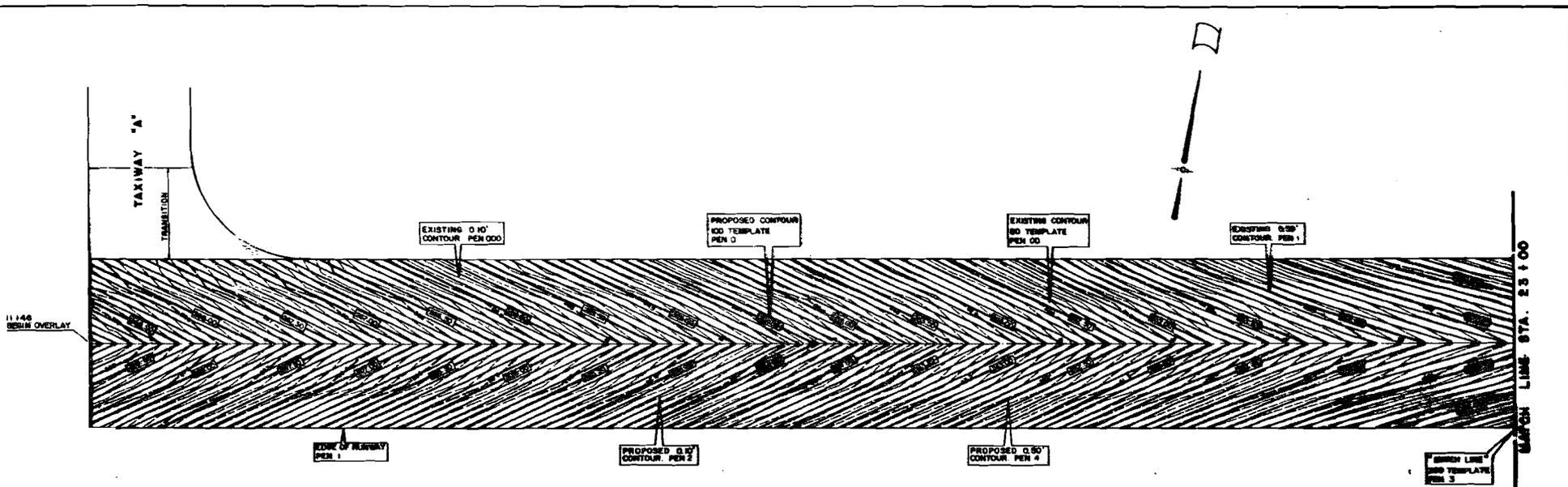
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CITY OF AERVILLE
 DEPARTMENT OF AVIATION
 AERVILLE MUNICIPAL AIRPORT

APPROVAL	
RECOMMENDED	
SUPERVISOR OF PUBLIC WORKS	
APPROVED	
DIRECTOR OF AVIATION	

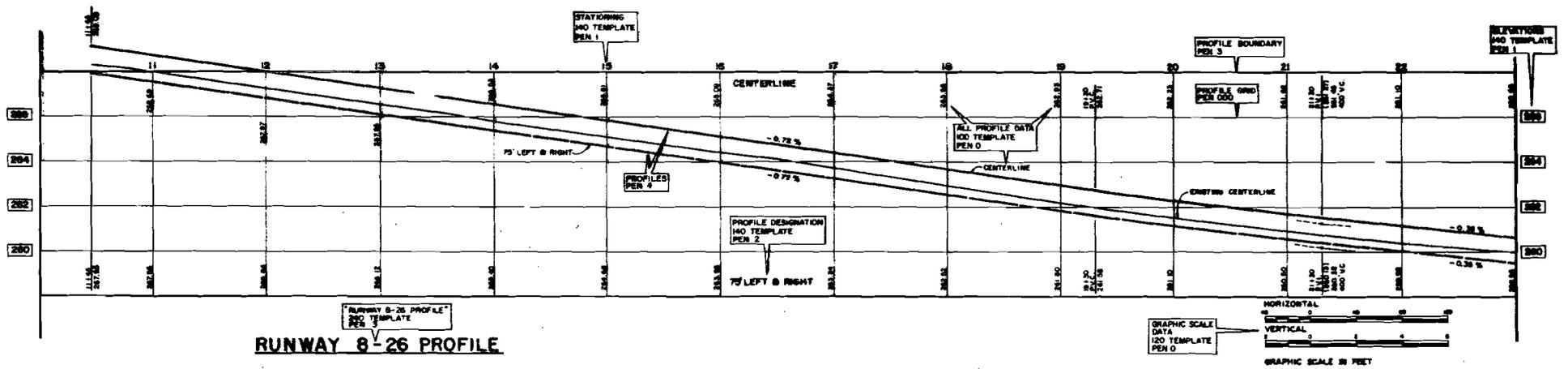
AERVILLE MUNICIPAL AIRPORT
 OVERLAY RUNWAY 8-26
 PAVING SECTIONS

DATE JULY, 1982
SHEET 4 OF 10
FILE NO. 8200-01
AADP NO. 1-00-0000-00



RUNWAY 8-26 PLAN

RUNWAY 8-26 PLAN
2ND TEMPLATE
PEN 3



RUNWAY 8-26 PROFILE



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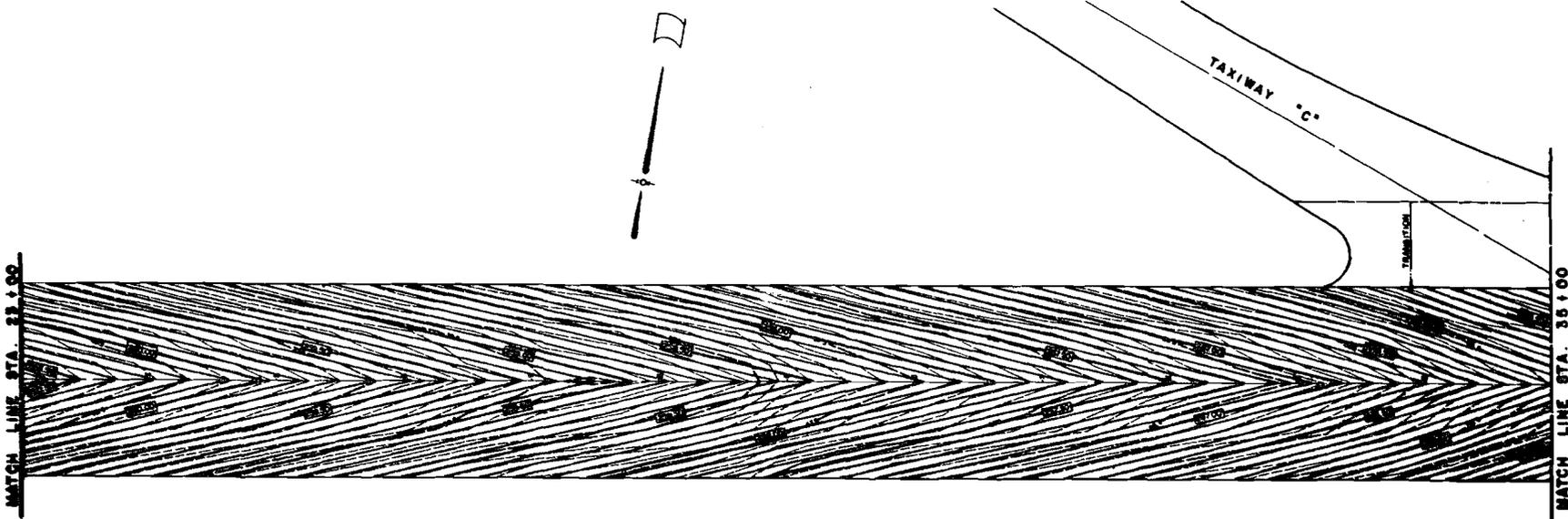
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DEPARTMENT OF AVIATION
AERVILLE MUNICIPAL AIRPORT

APPROVAL RECOMMENDED
APPROVED
DIRECTOR OF AVIATION

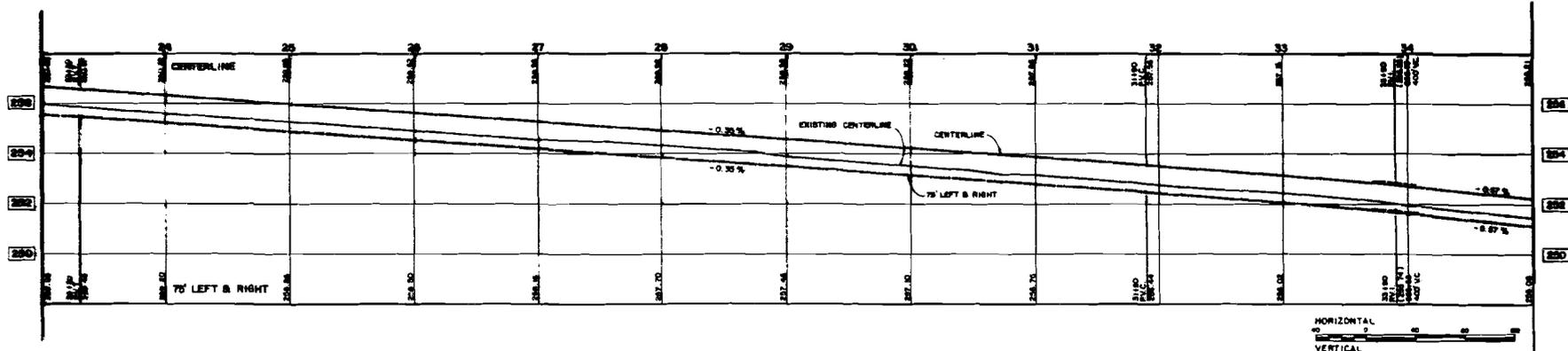
AERVILLE MUNICIPAL AIRPORT
OVERLAY RUNWAY 8-26
CONTOUR GRADING LAYOUT STA. 11146 TO STA. 23100

DATE JULY, 1982
SHEET 9 OF 14
FILE NO. 1200-01
ADAP NO. 1-00-0000-01

DATE	DESCRIPTION OF REVISIONS	DATE REV.

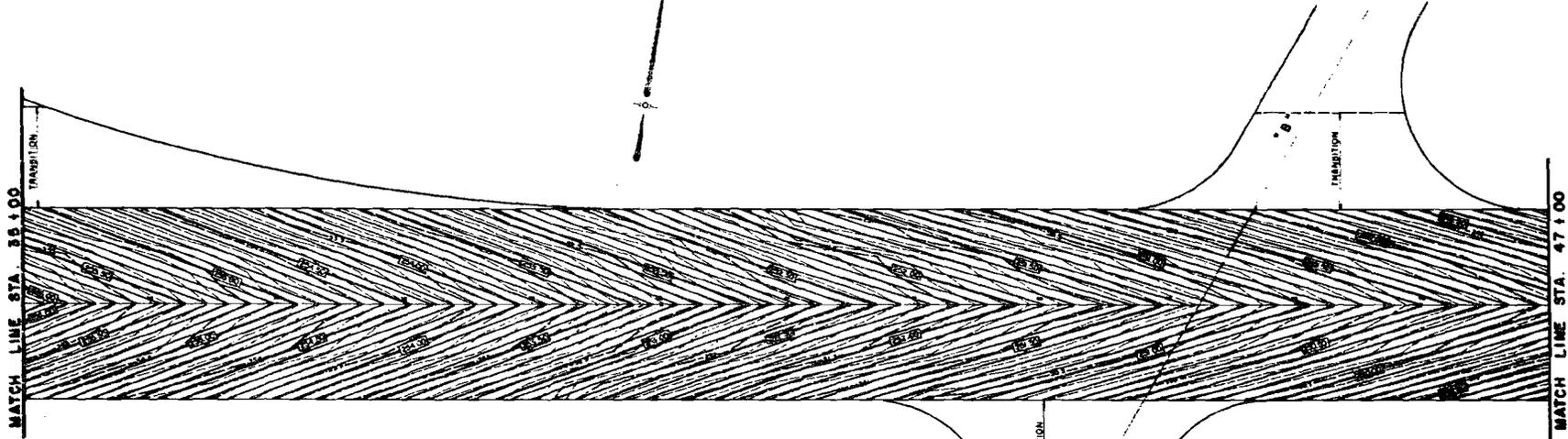


RUNWAY 8-26 PLAN

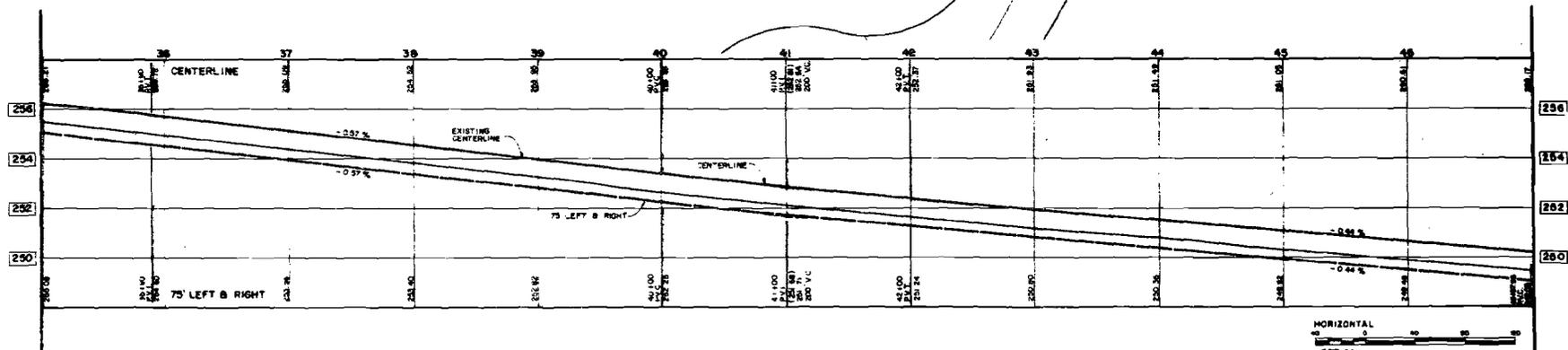


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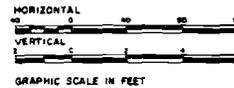
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			APPROVED	DIRECTOR OF AVIATION	SHEET 8 OF 14
			DIRECTOR OF PUBLIC WORKS	FILE NO G20 D - 81	ADAP NO 1-00-0000-01
			DIRECTOR OF AVIATION	CONTOUR GRADING LAYOUT STA. 23+00 TO STA. 35+00	
DRWD. BY DESCRIPTION OF REVISIONS DATE REV. #					



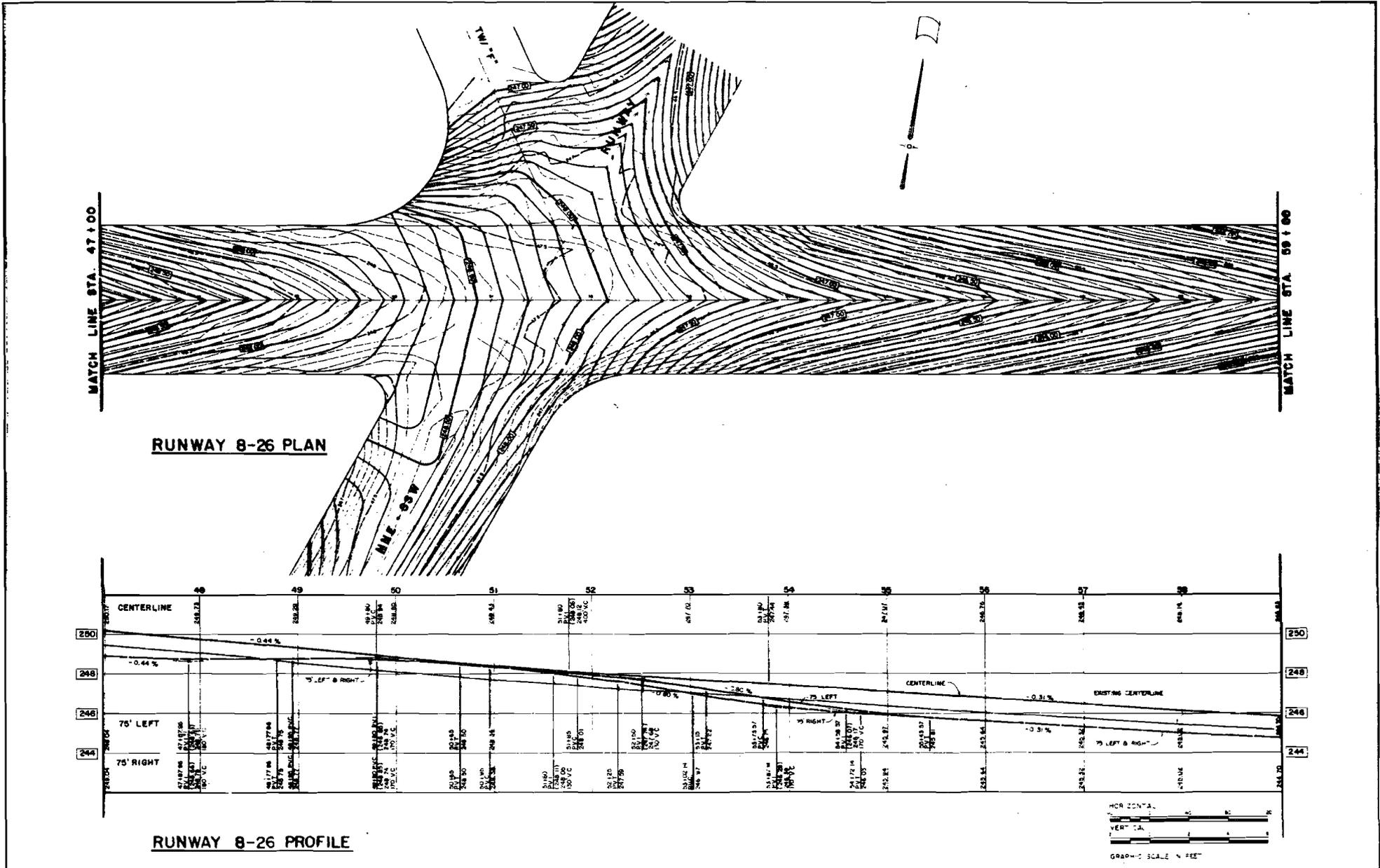
RUNWAY 8-26 PLAN



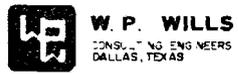
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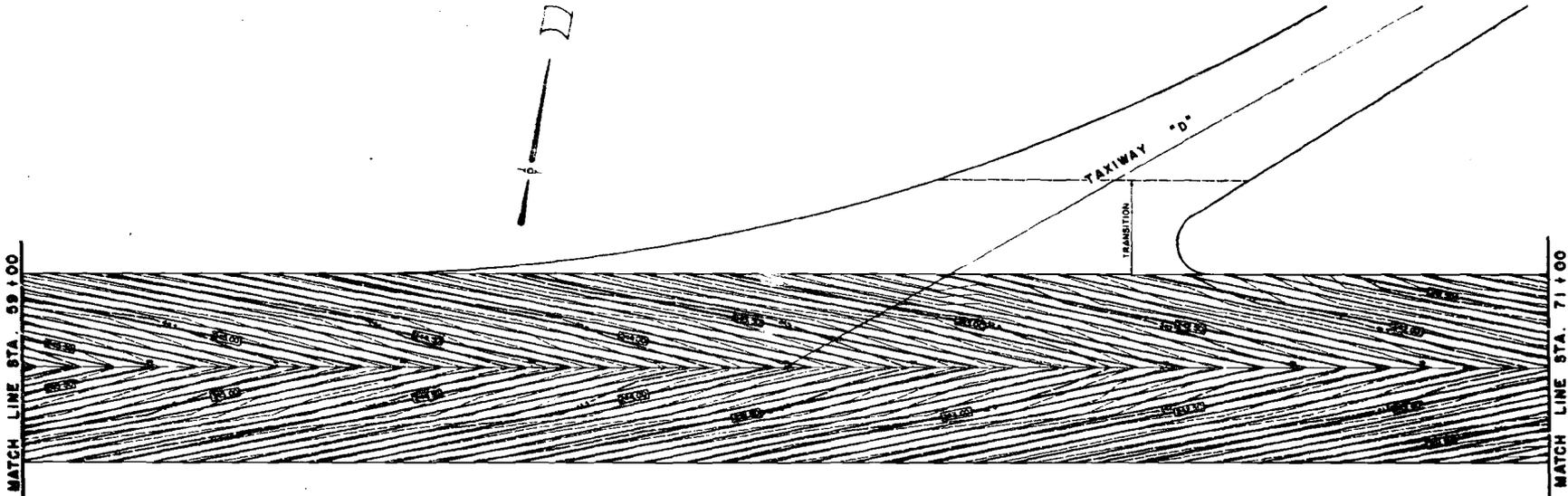
DESIGNED: _____ DRAWN: _____ CHECKED: _____	 W.P. WILLS CONSULTING ENGINEERS DALLAS, TEXAS	CITY OF AERVILLE DEPARTMENT OF AVIATION AERVILLE MUNICIPAL AIRPORT	APPROVAL: RECOMMENDED: _____ DIRECTOR OF PUBLIC WORKS SUPERVISOR: _____ DIRECTOR OF AVIATION: _____	AERVILLE MUNICIPAL AIRPORT OVERLAY RUNWAY 8-26	DATE JULY, 1982 SHEET 7 OF 14 FILE NO 1200-01
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REVISIONS: NO. BY DESCRIPTION OF REVISIONS	DATE REV. #				



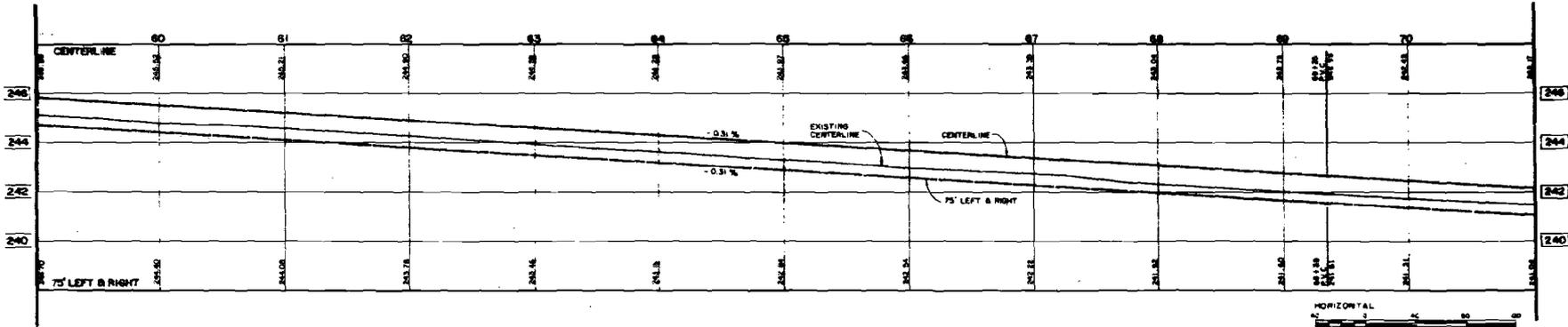
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			CONTOUR GRADING LAYOUT STA 47+00 TO STA 59+00	ADAP NO 1-00-000X-01



REVISIONS: _____

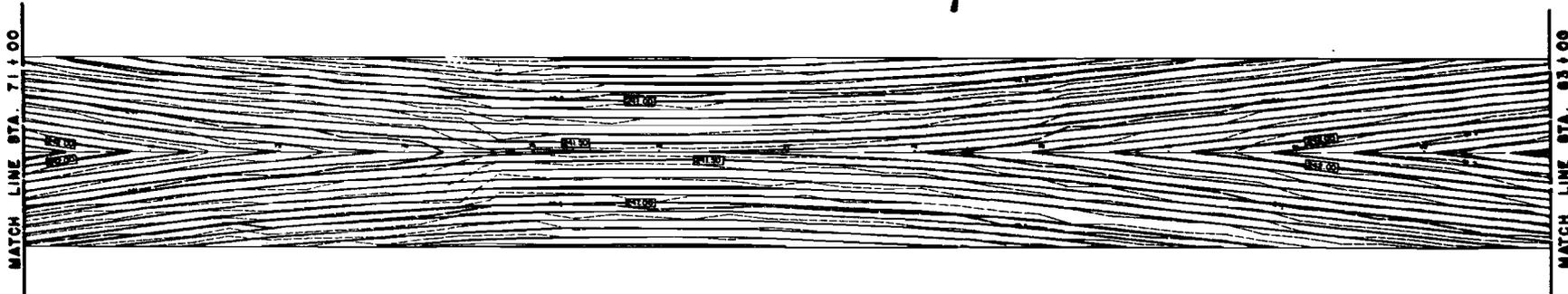


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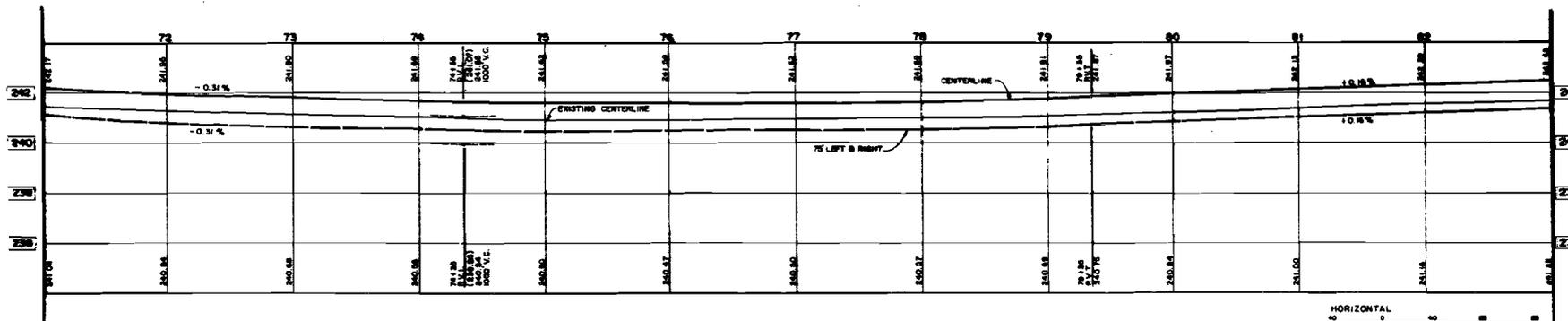


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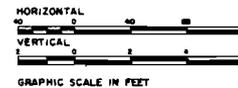
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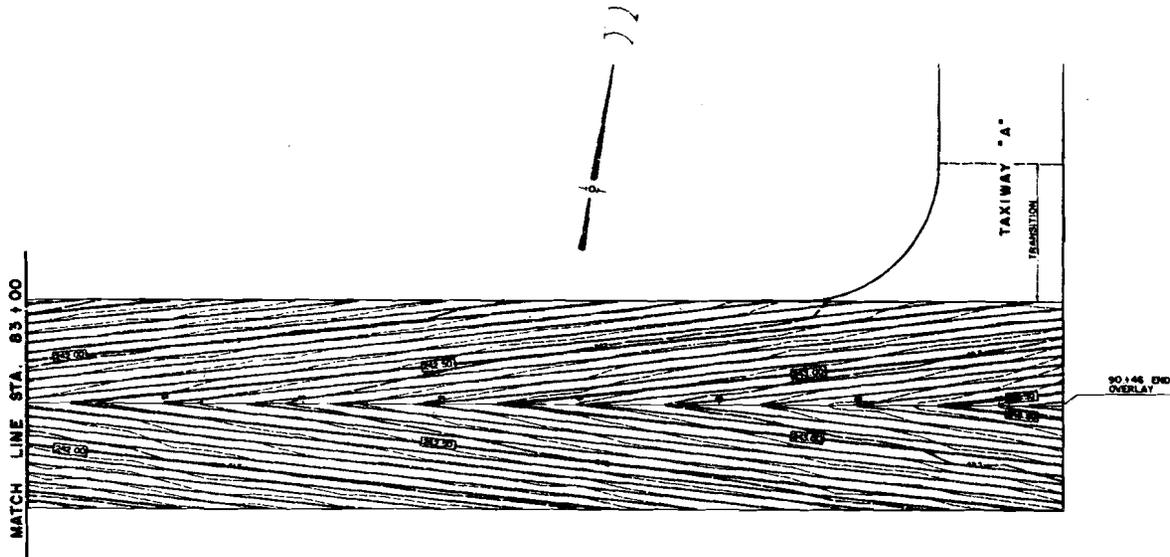
RUNWAY 8-26 PLAN



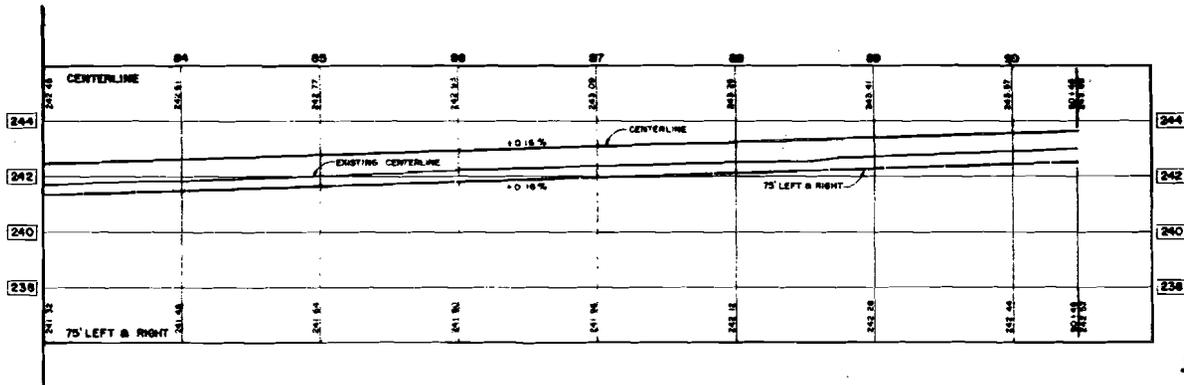
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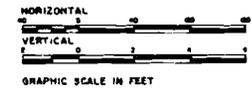
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			DIRECTOR OF PUBLIC WORKS APPROVED		SHEET 10 OF 14 FILE NO 120 D - 81
DESIGNED BY DESCRIPTION OF REVISIONS	DATE/REV #	DIRECTOR OF AVIATION	CONTOUR GRADING LAYOUT STA. 71+00 TO STA. 83+00	ADAP NO 1-00-0000-01	



RUNWAY 8-26 PLAN



RUNWAY 8-26 PROFILE



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						SHEET 11 OF 14 FILE NO. 200-D-81 ADAP. NO. 1-00-0000-01

TABULATION OF FINISHED GRADES

STATION	75' Left			50' Left			25' Left			Centerline			25' Right			50' Right			75' Right					
	FINISHED GRADE	EXISTING ELEVATION	DEPTH OVERLAY	FINISHED GRADE	EXISTING ELEVATION	DEPTH OVERLAY	FINISHED GRADE	EXISTING ELEVATION	DEPTH OVERLAY	FINISHED GRADE	EXISTING ELEVATION	DEPTH OVERLAY	FINISHED GRADE	EXISTING ELEVATION	DEPTH OVERLAY	FINISHED GRADE	EXISTING ELEVATION	DEPTH OVERLAY	FINISHED GRADE	EXISTING ELEVATION	DEPTH OVERLAY			
6750	242.76	241.68	0.08	242.74	241.67	0.07	242.72	241.65	0.07	242.70	241.63	0.07	242.68	241.61	0.07	242.66	241.59	0.07	242.64	241.57	0.07	242.62	241.55	0.07
6755	242.70	241.60	0.10	242.68	241.57	0.11	242.66	241.55	0.11	242.64	241.53	0.11	242.62	241.51	0.11	242.60	241.49	0.11	242.58	241.47	0.11	242.56	241.45	0.11
6760	242.64	241.54	0.10	242.62	241.51	0.11	242.60	241.49	0.11	242.58	241.47	0.11	242.56	241.45	0.11	242.54	241.43	0.11	242.52	241.41	0.11	242.50	241.39	0.11
6765	242.58	241.48	0.10	242.56	241.46	0.10	242.54	241.44	0.10	242.52	241.42	0.10	242.50	241.40	0.10	242.48	241.38	0.10	242.46	241.36	0.10	242.44	241.34	0.10
6770	242.52	241.42	0.10	242.50	241.40	0.10	242.48	241.38	0.10	242.46	241.36	0.10	242.44	241.34	0.10	242.42	241.32	0.10	242.40	241.30	0.10	242.38	241.28	0.10
6775	242.46	241.36	0.10	242.44	241.34	0.10	242.42	241.32	0.10	242.40	241.30	0.10	242.38	241.28	0.10	242.36	241.26	0.10	242.34	241.24	0.10	242.32	241.22	0.10
6780	242.40	241.30	0.10	242.38	241.28	0.10	242.36	241.26	0.10	242.34	241.24	0.10	242.32	241.22	0.10	242.30	241.20	0.10	242.28	241.18	0.10	242.26	241.16	0.10
6785	242.34	241.24	0.10	242.32	241.22	0.10	242.30	241.20	0.10	242.28	241.18	0.10	242.26	241.16	0.10	242.24	241.14	0.10	242.22	241.12	0.10	242.20	241.10	0.10
6790	242.28	241.18	0.10	242.26	241.16	0.10	242.24	241.14	0.10	242.22	241.12	0.10	242.20	241.10	0.10	242.18	241.08	0.10	242.16	241.06	0.10	242.14	241.04	0.10
6795	242.22	241.12	0.10	242.20	241.10	0.10	242.18	241.08	0.10	242.16	241.06	0.10	242.14	241.04	0.10	242.12	241.02	0.10	242.10	241.00	0.10	242.08	240.98	0.10
6800	242.16	241.06	0.10	242.14	241.04	0.10	242.12	241.02	0.10	242.10	241.00	0.10	242.08	240.98	0.10	242.06	240.96	0.10	242.04	240.94	0.10	242.02	240.92	0.10
6805	242.10	241.00	0.10	242.08	241.00	0.10	242.06	240.98	0.10	242.04	240.96	0.10	242.02	240.94	0.10	242.00	240.92	0.10	241.98	240.90	0.10	241.96	240.88	0.10
6810	242.04	240.94	0.10	242.02	240.92	0.10	242.00	240.90	0.10	241.98	240.88	0.10	241.96	240.86	0.10	241.94	240.84	0.10	241.92	240.82	0.10	241.90	240.80	0.10
6815	241.98	240.88	0.10	241.96	240.86	0.10	241.94	240.84	0.10	241.92	240.82	0.10	241.90	240.80	0.10	241.88	240.78	0.10	241.86	240.76	0.10	241.84	240.74	0.10
6820	241.92	240.82	0.10	241.90	240.80	0.10	241.88	240.78	0.10	241.86	240.76	0.10	241.84	240.74	0.10	241.82	240.72	0.10	241.80	240.70	0.10	241.78	240.68	0.10
6825	241.86	240.76	0.10	241.84	240.74	0.10	241.82	240.72	0.10	241.80	240.70	0.10	241.78	240.68	0.10	241.76	240.66	0.10	241.74	240.64	0.10	241.72	240.62	0.10
6830	241.80	240.70	0.10	241.78	240.68	0.10	241.76	240.66	0.10	241.74	240.64	0.10	241.72	240.62	0.10	241.70	240.60	0.10	241.68	240.58	0.10	241.66	240.56	0.10
6835	241.74	240.64	0.10	241.72	240.62	0.10	241.70	240.60	0.10	241.68	240.58	0.10	241.66	240.56	0.10	241.64	240.54	0.10	241.62	240.52	0.10	241.60	240.50	0.10
6840	241.68	240.58	0.10	241.66	240.56	0.10	241.64	240.54	0.10	241.62	240.52	0.10	241.60	240.50	0.10	241.58	240.48	0.10	241.56	240.46	0.10	241.54	240.44	0.10
6845	241.62	240.52	0.10	241.60	240.50	0.10	241.58	240.48	0.10	241.56	240.46	0.10	241.54	240.44	0.10	241.52	240.42	0.10	241.50	240.40	0.10	241.48	240.38	0.10
6850	241.56	240.46	0.10	241.54	240.44	0.10	241.52	240.42	0.10	241.50	240.40	0.10	241.48	240.38	0.10	241.46	240.36	0.10	241.44	240.34	0.10	241.42	240.32	0.10
6855	241.50	240.40	0.10	241.48	240.38	0.10	241.46	240.36	0.10	241.44	240.34	0.10	241.42	240.32	0.10	241.40	240.30	0.10	241.38	240.28	0.10	241.36	240.26	0.10
6860	241.44	240.34	0.10	241.42	240.32	0.10	241.40	240.30	0.10	241.38	240.28	0.10	241.36	240.26	0.10	241.34	240.24	0.10	241.32	240.22	0.10	241.30	240.20	0.10
6865	241.38	240.28	0.10	241.36	240.26	0.10	241.34	240.24	0.10	241.32	240.22	0.10	241.30	240.20	0.10	241.28	240.18	0.10	241.26	240.16	0.10	241.24	240.14	0.10
6870	241.32	240.22	0.10	241.30	240.20	0.10	241.28	240.18	0.10	241.26	240.16	0.10	241.24	240.14	0.10	241.22	240.12	0.10	241.20	240.10	0.10	241.18	240.08	0.10
6875	241.26	240.16	0.10	241.24	240.14	0.10	241.22	240.12	0.10	241.20	240.10	0.10	241.18	240.08	0.10	241.16	240.06	0.10	241.14	240.04	0.10	241.12	240.02	0.10
6880	241.20	240.10	0.10	241.18	240.08	0.10	241.16	240.06	0.10	241.14	240.04	0.10	241.12	240.02	0.10	241.10	240.00	0.10	241.08	239.98	0.10	241.06	239.96	0.10
6885	241.14	240.04	0.10	241.12	240.02	0.10	241.10	239.98	0.10	241.08	239.96	0.10	241.06	239.94	0.10	241.04	239.92	0.10	241.02	239.90	0.10	241.00	239.88	0.10
6890	241.08	239.94	0.10	241.06	239.92	0.10	241.04	239.90	0.10	241.02	239.88	0.10	241.00	239.86	0.10	240.98	239.84	0.10	240.96	239.82	0.10	240.94	239.80	0.10
6895	241.02	239.88	0.10	241.00	239.86	0.10	240.98	239.84	0.10	240.96	239.82	0.10	240.94	239.80	0.10	240.92	239.78	0.10	240.90	239.76	0.10	240.88	239.74	0.10
6900	240.96	239.82	0.10	240.94	239.80	0.10	240.92	239.78	0.10	240.90	239.76	0.10	240.88	239.74	0.10	240.86	239.72	0.10	240.84	239.70	0.10	240.82	239.68	0.10
6905	240.90	239.76	0.10	240.88	239.74	0.10	240.86	239.72	0.10	240.84	239.70	0.10	240.82	239.68	0.10	240.80	239.66	0.10	240.78	239.64	0.10	240.76	239.62	0.10
6910	240.84	239.70	0.10	240.82	239.68	0.10	240.80	239.66	0.10	240.78	239.64	0.10	240.76	239.62	0.10	240.74	239.60	0.10	240.72	239.58	0.10	240.70	239.56	0.10
6915	240.78	239.64	0.10	240.76	239.62	0.10	240.74	239.60	0.10	240.72	239.58	0.10	240.70	239.56	0.10	240.68	239.54	0.10	240.66	239.52	0.10	240.64	239.50	0.10
6920	240.72	239.58	0.10	240.70	239.56	0.10	240.68	239.54	0.10	240.66	239.52	0.10	240.64	239.50	0.10	240.62	239.48	0.10	240.60	239.46	0.10	240.58	239.44	0.10
6925	240.66	239.52	0.10	240.64	239.48	0.10	240.62	239.46	0.10	240.60	239.44	0.10	240.58	239.42	0.10	240.56	239.40	0.10	240.54	239.38	0.10	240.52	239.36	0.10
6930	240.60	239.46	0.10	240.58	239.44	0.10	240.56	239.42	0.10	240.54	239.40	0.10	240.52	239.38	0.10	240.50	239.36	0.10	240.48	239.34	0.10	240.46	239.32	0.10
6935	240.54	239.40	0.10	240.52	239.38	0.10	240.50	239.36	0.10	240.48	239.34	0.10	240.46	239.32	0.10	240.44	239.30	0.10	240.42	239.28	0.10	240.40	239.26	0.10
6940	240.48	239.34	0.10	240.46	239.32	0.10	240.44	239.30	0.10	240.42	239.28	0.10	240.40	239.26	0.10	240.38	239.24	0.10	240.36	239.22	0.10	240.34	239.20	0.10
6945	240.42	239.28	0.10	240.40	239.26	0.10	240.38	239.24	0.10	240.36	239.22	0.10	240.34	239.20	0.10	240.32	239.18	0.10	240.30	239.16	0.10	240.28	239.14	0.10
6950	240.36	239.22	0.10	240.34	239.20	0.10	240.32	239.18	0.10	240.30	239.16	0.10	240.28	239.14	0.10	240.26	239.12	0.10	240.24	239.10	0.10	240.22	239.08	0.10
6955	240.30	239.16	0.10	240.28	239.14	0.10	240.26	239.12	0.10	240.24	239.10	0.10	240.22	239.08	0.10	240.20	239.06	0.10	240.18	239.04	0.10	240.16	239.02	0.10
6960	240.24	239.10	0.10	240.22	239.08	0.10	240.20	239.06	0.10	240.18	239.04	0.10	240.16	239.02	0.10	240.14	239.00	0.10	240.12	238.98	0.10	240.10	238.96	0.10
6965	240.18	238.94	0.10	240.16	238.92	0.10	240.14	238.90	0.10	240.12	238.88	0.10	240.10	238.86	0.10	240.08	238.84	0.10	240.06	238.82	0.10	240.04	238.80	0.10
6970	240.12	238.88	0.10	240.10	238.86	0.10	240.08	238.84	0.10	240.06	238.82	0.10	240.04	238.80	0.10	240.02	238.78	0.10	240.00	238.76	0.10	239.98	238.74	0.10
6975	240.06	238.82	0.10	240.04	238.80	0.10	240.02	238.78	0.10	240.00	238.76	0.10	239.98	238.74	0.10	239.96								

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