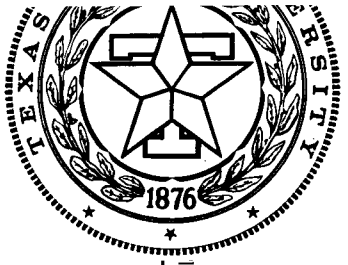

TEXAS TRANSPORTATION INSTITUTE

TEXAS HIGHWAY DEPARTMENT

COOPERATIVE RESEARCH

Wood Products in Connection with Highway Programs

in cooperation with the
U. S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads

BIBLIOGRAPHY -205

SURVEY OF LIBRARY FACILITIES PROJECT

WOODS PRODUCTS IN CONNECTION WITH HIGHWAY PROGRAM

1. Gatchell, Charles J. A WAY TO REDUCE HIGHWAY GUARD RAIL COSTS: MACHINE-DRIVING OF WOODEN POSTS. U.S. Forest Service, Research Paper NE-81, 1967. 19 pp. (Available from U.S. Dept. of Agriculture, Forest Service, Washington, D. C. 20250). HR Abstracts, April 1968.

   Because of desirable strength characteristics, long service life, and low cost, pressure-treated wooden guardrail posts are completely acceptable and in many ways preferable to posts made from other materials. With the introduction of machine-driving, the rate of installation of wood is now competitive with that of machine-driven steel. The results of this study where steel posts can be driver They also can be driven on some sites where steel cannot and where an auger cannot and where an auger cannot be used. On the same site, posts can be set at least twice as fast by machine-driving as by hand-setting. The subcontractor can save $1 to $2 per installed post by machine-driving. For machine-driving, posts with blunt bottoms are preferable to those with slopes. The driving action will cause no damage to the tops of properly machined wooden posts.

2. Fossberg, P. E. THE TREATMENT OF GRAVEL ROADS WITH WASTE SULPHITE LYE. National Institute for Road Research, Council for Scientific and Industrial Research, Pretoria, South Africa, CSIR Research Report 243, 1966. 36 pp. HR Abstracts, September 1967.

   An investigation into the use of sulphite lye for treating gravel roads to improve wearing quality, for reducing the rate of loss of material under traffic, and for reducing dust, is described. The study comprised laboratory work on the lye and on its effect on soil properties. Full-scale road experiments were done in Natal and the Transvaal to study the behavior under traffic of different gravels stabilized with the lye. Those properties of the gravels that govern their road behavior are described. Mix-in-place stabilization, in which one percent by weight of sulphite lye solids was incorporated to a depth of 3 to 4 inches, reduced the dust nuisance considerably and also reduced the loss of material under traffic. Cost studies showed that the lye should be transported over long distances in a concentrated form because the dilute raw liquor can only be transported economically over short distances. Unfortunately the factory cost of concentrating the material places a limit on its economic use. In fact, an overall assessment reveals that at the present time its use is uneconomic farther than 50 miles from the source of supply, unless special circumstances prevail.

3. Dudeck, A. E. MULCHES FOR GRASS ESTABLISHMENT ON STEEP CONSTRUCTION SLOPES. Universtiy of Nebraska. Presented at the Highway Research Board meeting, January 1967.

   Thirteen mulch treatments were evaluated on plots seeded to Lincoln bromegrass on a 3:1 roadside backslope in September 1965. Plots protected with excelsior mat, prairie hay anchored with a loose paper netting, or a combination of emulsifiable asphalt as an acchorage for woodships, chopped corncobs, prairie hay, or wood cellulose had significantly more grass cover than did the no-mulch treatment. Although differences in soil moisture percentages and soil temperatures

between mulch treatments were statistically stands with one exception. The poor stand of grass on the plot mulched with emulsifiable asphalt may have been due to high soil temperatures and the wide range between soil temperature extremes. The rate of 1200 gallons per acre also may have been excessive for good germination. Differences between mulches probably would have been greater under conditions of normal, or preferably below normal, precipitation.

4. Blew, J. Oscar, Jr. and Kulp, John W. COMPARISON OF WOOD PRESERVATIVES IN MISSISSIPPI, POST STUDY (1964 PROGRESS REPORT). U.S. Forest Service Research Note FPL-01. Forest Products Laboratory, Forest Service, U.S. Dept. of Agriculture (Madison Wis.), Feb. 1964. HR Abstracts, February 1965.

Experimental untreated southern yellow pine posts installed between 1936 and 1938 at the Harrison Experimental Forest, Saucier, Miss., had an average life of 3.3 yr. Untreated longleaf pine posts installed in 1949 had an average life of 2.3 yr, whereas those treated with a No. 2 fuel oil and with Wyoming residual petroleum oil have an estimated average life of 5 and 8 yr, respectively. Of southern yellow pine posts installed between 1936 and 1941, those treated with borax-boric acid have all failed after an average of 10.6 yr and those treated at the groundline and top with Osmoplastic have all failed after an average of 11.2 yr. Posts treated with the following preservatives and installed between 1936 and 1941 have had failures totaling 10 percent or less and should last an average of 43 yr or longer: pentachlorophenol, 4.8 percent in crankcase oil; copper sulfate and sodium arsenate applied by double diffusion; and zinc metaarsenate. Posts in test between 1936 and 1941 treated with other preservatives have an estimated average life of 8 to 42 yr.

5. Knisley, Harold L., Jr. WOOD BREAK-AWAY POSTS PROVIDE SAFETY FOR MOTORISTS. Traffic Engineering (1725 DeSales St., N. W., Washington, D. C. 20036), Vol. 34, No. 11, p. 17, Aug. 1964. HR Abstracts, November 1964.

Wood breakaway posts, designed to provide the structural capabilities required for sign support, and still afford an optimum of breakaway potential if struck by a vehicle, have been tested and evaluated by the Pennsylvania Department of Highways.

Installed on I-90 near Erie, the post supported the 5- x 6-ft gore exit directional signs required by the Interstate manual. These signs were selected as the most susceptible to accident damage, and a total of 24 gore installations and 24 off-ramp terminal installations were made on 12 diamond interchanges in a 45-mi area. The installations were purposely left devoid of guard fence protection as an additional safety feature.

Coastal region Douglas fir of the select structural grade specified by AWPA is used for the breakaway posts. Water soluble perservatives are specified to allow for the painting of the posts, which is done with field coats of black, white and green patina.

Test design standards provide for 8- x 6-in. post dimensions above ground and 6- x 4-in. dimensions at ground level. The tapered end sections of the posts are inserted into galvanized steel sleeves set in Class B concrete foundations and are sealed with a bituminous material.

During the 2-yr study, detailed reports and photographs were obtained from the district field offices whenever installations suffered vehicular damage, and were analyzed as to the propriety of design. Correlation of the analysis of these

accident studies indicates that the wood breakaway posts have performed as the designer intended and are providing a practical, economical safety feature on Pennsylavania's highways.

6. Russell, W. L. A MACHINE FOR SPREADING COATED CHIPPINGS ON ROLLED ASPHALT. Roads and Road Construction (147 Victoria St., London, S.W.1), Vol. 41, No. 483, pp. 70-73, March 1963. HR Abstracts, November 1963.

This article describes a machine developed at the Road Research Laboratory and now in commercial production for spreading the coated chippings which are rolled into the surface of rolled asphalt to give a non-skid texture. It is a self-propelled machine which spreads chippings over a width of 12 ft at one pass at a pre-set rate of spread. It runs on pneumatic-tired wheels on hard surfaces outside the newly laid asphalt. A traveling loading skip, which can be filled by mechanical shovel at either side of the machine, distributes the chippings along the 12-ft length of the main hopper. Fluted rotors, which are geared to the road wheels, deliver a metered flow of chippings to the road that is unaffected by variations in the speed of travel of the machine. The machine enables chippings to be spread evenly on the asphalt at any predetermined rate. The machine is very maneuverable and is operated by one man. In its present form it is primarily intended for roadway or similar new construction work, but a smaller machine built to the same design principles is being produced for use in work on other roads.

7. SULPHITE LYE FOR GRAVEL ROADS. C.S.I.R. Research Review, South African Council for Scientific and Industrial Research, (P.O. Box 395, Pretoria, South Africa), Vol. 12, No. 2, pp. 38-40, June 1962.

To test the performance of roads treated with sulphite lye several fullscale field experiments have been undertaken by the National Institute of Road Research. These experiments include trials on four miles of road near Natal, a two-mile length north of Pretoria and about 0.4 mi at Zebediela in the Northern Transvaal. Two different techniques have been employed, viz, a surface spray only and a mixed-in-place stabilization of the upper 3-4 in. layer of soil, followed by compaction. Further experiments are planned in Natal and the Kruger National Park.

The experiments conducted so far have yielded much valuable information. The binding, waterproofing and cementing effects of sulphite lye have been clearly demonstrated. On the other hand, it has been found, for instance, that particle size distribution of the gravel must be within limits that make the gravel stable in itself. Failing this, considerably larger amounts of sulphite lye have to be added. This problem is closely tied up with the leaching out of the lye, as it is readily soluble in water. During heavy rains some lye is inevitably washed out. Gravels of correct particle size distribution and plasticity will, however, offer greater resistance to leaching out that gravels not complying with these requirements.

Laboratory tests and the field experiments were conducted concurrently. It has been shown that the dry strength of the soil is increased by the addition of sulphite lye. Furthermore, addition of sulphite lye reduces the optimum moisture content required for compaction and brings about an increase in the maximum dry density obtained, both effects being beneficial in road construction.

Sulphite lye, having a pH in the range 2-3 has been found to be corrosive to steel under certain conditions, and simple methods for the protection of tankers

used for distribution of sulphite lye are therefore, being investigated.

In general, it may be said that the correct use of sulphite lye for treatment of gravel roads offers potential benefits through greater economy in the maintenance of these roads by road authorities, and safer and more comfortable travel by the general public.

8. Blew, J. Oscar. WHAT CAN BE EXPECTED FROM TREATED WOOD IN HIGHWAY CONSTRUCTION. Forest Products Laboratory, U.S. Forest Service, Madison, Wisconsin. Presented at the Highway Research Board meeting, January 1961.

The important factors influencing the performance of treated wood are the quality of the preservative and the quantity and distribution obtained during treatment. These factors are discussed, and the service data from Forest Products Laboratory tests and those of various railroads and highway departments on treated posts, piles, and timbers are presented.

9. TWO CITIES' EXPERIENCE WITH PLYWOOD TRAFFIC SIGNS. Street Engineering (22 W. Maple St., Chicago 10, Ill.), Vol. 6, No. 2, pp. 24-25, 34, February 1961. HR Abstracts, May 1961.

High-density overlaid plywood as a material for traffic signs, which first gained national acceptance with the Interstate highway program, is following the highroads into the cities. While this type of sign construction is still new in many cities, its use in others is as old as the yellow stop sign.

As reported by the Douglas Fir Plywood Association, the cities of Tacoma and Seattle, Washington, both have used plywood signs for many years and use them today for every conceivable application, including the smaller restrictive-type signs. Some of these regulative signs in Tacoma have been in continuous service for more than 7 years. Seattle has plywood signs which have been in use 15 years.

Two major developments in plywood manufacture have made softwood plywood panels useful as traffic signs. The first was the development of exterior flue which forms a highly permanent bond between the plys. Phenolformaldehyde adhesive creates a bond so strong that no exposure to water, weather, heat or cold can weaken it.

Plywood in a few areas has been used since as far back as the 1930's for traffic signs. However, the standard exterior panel has a disadvantage in sign applications because of face checking or grain raise that tends to cause flaking of the sign surface.

This problem was eliminated with the more recent development of high-density overlaid fir plywood. The panels are overlaid with a resin-impregnated fiber surface that is permanently fused to the plywood. This surface gives a smooth, plastic-like covering well suited for sign uses. A special panel with a green overlay (Kimpreg 8000 green) was developed for use in the Interstate highway program.

One of the earlier users of the high-density overlay panels for signs was the Wisconsin State Highway Commission. Other early users include the Port of New York Authority which uses high-density panels for regulatory and directional signs on bridge, tunnel, highway and airport approaches; also the Texas Highway Department (Gulf Freeway at Houston) and the Washington State Highway Department. After success in these areas, plywood became one of the standard sign materials along the Interstate highway system.

Tacoma's traffic engineer, Yoshio Kasai, reports that the advantages of plywood signs for city applications are much the same as those shown in rural highway signs: low initial cost, resistance to vandalism, durability and low maintenance.

0. Penner, E. and Robillard, P. THE USE OF WASTE SULPHITE LIQUOR TO REDUCE FROST HEAVING IN SOILS. Transactions of the Engineering Institute of Canada (2050 Mansfield St., Montreal 2, Quebec), Vol. 3, No. 4, pp. 107-109, December 1959. HR Abstracts, May 1960.

The treatment of frost-susceptible soils with waste sulphite liquor has been shown to be reasonably successful. Its effectiveness has been atrributed to the change in moisture permeability brought about by, (1) a greater viscosity in the pore fluid and (2) its dispersant action when mixed with soil which results in a greater density and hence a lower permeability.

Ice crystallization measurements in waste sulphite liquor solutions reported in the paper show the rate to be greatly affected by the concentration of the solution. For example, at 10 deg C of supercooling the rate of ice crystallization in pure water was 116 times greater than in a 50 percent solution. The suggestion is that the reduction in frost heaving resulting from a waste sulphite liquor treatment can be attributed partly to the slower rate of ice growth.

1. La Touche, David E. SOIL STABILIZATION WITH LIGNOSOL. Roads and Engineering Construction (341 Church St., Toronto 2, Ont.), Vol. 97, No. 12, pp. 66-69, December 1959. HR Abstracts, May 1960.

Calcium lignosulfonate, or Lignosol, is spent sulphite liquor, a product of the pulp and paper industry. It has been used for many years in Europe and the United States, on roads, for the control of dust. Its adhesiveness has been its prime value to users as it binds together fine particles, effectively preventing dusting.

In 1944, the effect of Lignosol on bearing capacity, compressive strength, and permeability was measured by G. Piette and G. Demers who reported their findings in "Roads and Bridges," (now "Roads and Engineering Construction"), September 1945.

The report showed that while the compressive strength of Lignosol stabilized gravel is reduced by the presence of excessive moisture, its actual resistance to moisutre is good. When comparing the percentage water absorbed over a 37-day period by a dry clay stabilized gravel and a Lignosol stabilized gravel, both dry and at initial moisture contents of 1.5 percent and 3.0 percent, the strength of a Lignosol stabilized foundation is retained to a comparatively high degree, and leaching is extremely slow.

On the basis of these results, the Province of Quebec Highways Department applied Lignosol on about 320 mi of highway between 1944 and 1952. A 28 percent solution was applied with a spray truck in 2 stages, to a total of 1.2 gal/sq yd, on fresh base material. Paving was placed directly on the Lignosol bound gravel with no primer coat being used.

The Highway Department reports that the required effects which they sought from Lignosol were obtained. These were: (1) a stronger base which retained the grade, and (2) prevention of washboarding due to traffic during construction.

In 1952, the Canadian National Railway with Lignosol Chemicals Limited embarked on a program to test work to determine the field performance and

economic value of Lignosol in preventing frost heaving. Although laboratory test work has indicated that calcium lignosulfonate reduced frost heaving this was the first time its evaluation was moved from the laboratory to the field to demonstrate that its use could result in considerable reduction in maintenance cost. Over a 5 yr period, Canadian National Railway's records indicate that an expenditure of $5,700 for Lignosol treatment accounted for a net saving of $5,500 with 80 percent success.

For existing railway embankments, treatment has been made by injecting a solution, containing 40 percent solids, into a layer of soil above the ground water level. This operation proceeds similarly to grouting of embankments with cement. There are, of course, equipment modifications which have been directed towards making the operation more efficient. Treatment aims at placing a concentration of 3 percent Lignosol solids in a layer of soil 1 ft thick at a depth of 4 or 5 ft, if the depth of the frost susceptible soil is unknown. Where the depth of the frost susceptible soil is known, Lignosol is injected in such a manner as to prevent absorption of moisture by the soil.

Speculation, as to the reason for successful treatment, has been that Lignosol renders the frost susceptible soil impermeable to moisture. The lower permeability of the soil after treatment slows down the rate at which water can be taken up for ice lens formation. In other words, the source of water is effectively removed. There is some evidence to support this. In 1956, tests were run on frost heaving soil taken from a Canadian National Railway embankment near Winnipeg to determine: (1) Grain size analysis; (2) Consistency limits (fraction passing No. 40 mesh sieve) on material as received and with additions of 0.2 and 0.5 percent by weight of Lignosol; (3) Compaction characteristics (Standard AASHO) on material as received, and on material containing 0.2 percent and 0.5 percent by weight of Lignosol; and (4) Permeability of compacted material (dry unit weight of 107 lb/cu ft) with material as received and containing 0.2 percent and 0.5 percent Lignosol.

12. DURATION OF LOAD AND FATIGUE IN WOOD STRUCTURES. Progress Report of a Sub-Committee of the Committee on Timber Structures of the Structural Division. Proc. American Society of Civil Engineers (33 West 39th St., New York 18, N.Y.), Vol. 83, Journal of the Structural Division, pp. 1361-1--1361-12, Sept. 1957. HR Abstracts, April 1958.

This paper summarizes present knowledge of the effect of long-time loading and of fatigue on structural wood. Long-time loading, whether continuous or intermittent, is considered from the viewpoints both of strength and of deformation. A chart showing the relation of safe working stress to duration of load is presented. Fatigue test data are reviewed, and representative S-N curves are shown. It is noted that fatigue failures are generally less of a problem in wood structures than in those constructed of other materials.

A section on the evaluation of old timbers in structures is included. It shows how old timbers can be appraised in terms of their species, grade and condition to give a reliable estimate of their present structural value.

13. SONIC TREATMENT AND TESTING OF WOOD. Research and Engineering, Vol. 1, No. 1, pp. 47-48, July-August 1955. HR Abstracts, January 1956.

A study of sonic and ultrasonic vibrations in the testing and water-repellent treatment of refractory woods was conducted in an attempt to develop an economical and effective method of treating them to prevent shrinking and swelling and

to investigate the use of sonic vibrations in testing the strength of wood beams and timbers.

Comparative tests of ultrasonic, dip and pressure treatments, using commercial water-repellents and water-glycol solution, indicated that ultrasonic vibrations of 440 kc. and above improved absorption and anti-swell efficiency of hard-to-treat woods. White pressure treatment gave generally better results under test conditions, the ultrasonic-vibration treatment shows some improvement over the dip method and gives promise of still better results when techniques of application are fully developed.

The sonic testing of strength properties of wood appears to offer several commercial advantages. By this method of measuring resonant frequencies, weakening defects in wood beams and construction items can be discovered without test damage to the wood. Standing timber may also be tested to determine its soundness.

Report is titled "Application of Ultrasonic and Sonic Vibrations for Improvement and Testing of Wood." (Final Report), PB 11156, 59 pp., $1.50. Available from Office of Technical Services, U.S. Department of Commerce, Washington 25, D. C.

14. Hardy, R. M. PREVENTION OF FROST HEAVING BY INJECTION OF SPENT SULPHITE LIQUOR. Proc. 3rd Internat. Conf. Soil Mech., 1953, 2, 103-6. (In English, with French summary.) Road Abstracts, Vol. 21, No. 3, March, 1954. HR Abstracts, May 1954.

It is noted that heaving of surfaces due to freezing of moisutre in the clay and silt soils which are widespread in Canada is of the order of 1/2 inch per foot of frost penetration but seldom results in "frost boils." Damage frequently results, however, from migration of water to the frost line and the formation of layers of lenses of ice. In laboratory tests, the heaving of samples of silty soil treated with 3 to 5 percent by weight of lignosol (spent sulphite liquor) was less than 10 percent of that of untreated soil samples; tests also indicated that though leaching of lignosol is likely to occur it may be very slow under field conditions. Four field sites have been treated and observed for three winters. It is said that fairly satisfactory methods have been developed for injecting lignosol solution into the soil by a pressure grouting technique. Grouting was done at depths of 4 to 6 feet below the surface in holes spaced at 6- to 12-foot centers. This procedure is thought to reduce frost heave for at least 3 years, but in fine sand or coarse silt leaching may be more rapid. The relatively high viscosity of lignosol solutions is thought to be a major reason for the effectiveness of the treatment in reducing ice segregation.

15. Hudson, Monie S. SOLVENT RECOVERY FROM PENTACHLOROPHENOL-TREATED WOOD. Industrial and Engineering Chemistry, Vol. 45, No. 7, pp. 1576-1583, July 1953. HR Abstracts, October 1953.

When wood is pressure treated with pentachlorophenol in volatile solvents, most of the chemical is brought to the surface of the wood by evaporation of the solvent, leaving objectionable deposits which interfere with paintability. Addition of plasticizing agents to the treating solution prevents formation of the crystalline deposits known as blooming but does not stop the migration of pentachlorophenol to the surface. By employing a modification of the vapor-drying process, it is possible to remove and recover most of the solvent vehicle that is normally lost. Usually 6 to 10 lb. per cu. ft. of solution containing

5-percent pentachlorophenol in the solvent is required for pressure impregnation of wood. The cost of the solvent portion of this solution amounts to from $12 to $18 per thousand board-feet of wood processed, while the value of the pentachlorophenol itself is only about $5 to $9. The solvent can be recovered by means of the vapor process at a cost of about $6 to $8 per thousand board feet, which represents a decided economic advantage. In addition to the saving obtained by removal of this solvent, the vapor process produces a finished product that is free of surface deposits of natural resins and of preservative impregnant that cause discoloration and other defects of paint applied to the wood.

16. SULFITE LIQUOR AIDS IN RESURFACING BLACKTOP ROAD. Chemical and Engineering News, Vol. 30 No. 44, p. 4628, November 3, 1952. HR Abstracts, January 1953.

Another use of spent sulfite liquor has come from an experiment conducted in Wisconsin about a year ago. At that time, a county road supervisor was hurrying to resurface a badly damaged blacktop road. Experiencing some difficulty in breaking up the blacktop chunks, he decided to try the sulfite roadbinder which has been used recently for firt roads.

After spreading the sulfite binder, he found that it crumbled to a fine texture under a grader blade. The softening action was only temp rary, however, and he was able to produce a smoothed surface without adding further asphalt. The surface hardened until it was almost as good as new blacktop. Tests throughout last winter showed satisfactory performance under a winter load.

The Sulphite Pulp Manufacturers' Research League, Appleton, Wisconsin and the University of Wyoming's Highway Engineering Laboratory studied this use of spent sulfite liquor and found it a practical treatment. Several road tests were made during the past summer. A committee of the SPMRL has been studying the results of these researches and finds them encouraging but warns that use of sulfite liquor for reconditioning blacktop is too new for final approval and much more experimentation is necessary.

17. Arnold, L. K. and Walker, R. E. WOOD PRESERVATION. Iowa Engineering Experiment Station, Iowa State College, Bulletin 174, 1953, 92 pp. HR Abstracts, July 1953.

Experiments were conducted with atmospheric-pressure and high-pressure methods of injecting a 5-percent solution of pentachlorophenol into fir poles to improve the depth of penetration and to produce an oil-free surface.

Laboratory atmospheric pressure treatments (hot and cold baths) of pole sections 1, 2, and 3 ft. long showed that deeper penetrations could be obtained in coast-type than in mountain-type Douglas fir, and that incising of the mountain-type did not improve the penetration materially but did increase the retention. Neither the penetrations nor retentions in either type of wood were entirely satisfactory, unless uneconomically long treating times were used.

Laboratory experiments, followed by commercial-scale experiments, showed that two modifications of the high-pressure treatment - oil-water and pressure reduction treatments - gave deeper penetrations than the conventional Lowry treatment. In the oil-water treatment oil was impregnated to the desired retention and was followed with water. The oil penetration was increased by introducing the water into the treating cylinder at the oil-treating pressure by using high water pressure, and by extending the water-pressure period. Bleeding was reduced by extension of the water-pressure period, by lowering the water pressure, and by removal of water after injection by a steaming-and-vacuum cycle. In the pressure-

reduction treatment, the oil was initially impregnated at high pressure, and the treating pressure was reduced to atmospheric pressure during the treatment at such a rate that the desired retention was obtained. In these treatments a higher retention was obtained in the incised wood than in the nonincised wood and than in the conventional Lowry treatment.

A theory was developed that air is trapped within the treated wood and that the degree of compression of this trapped air controls the volume and distribution of the injected oil. From this theory the two general effects of treating conditions can be predicted: (1) An increase in retention of 2 lb. of oil per cu. ft. of wood between a 6-and-8-lb. retention will cause a greater increase in penetration than between a 2-and-4-lb. retention. (2) For a given retention of injected oil, lower treating pressures and higher temperatures tend both to increase penetrations and to retard the accumulation of surface oil.

Recommendations for atmospheric and high pressure treating schedules are given.