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Field Notes

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Accelerated Determination of Concrete Compressive Strength

Color Infrared Film Developed to a Negative

Regional Division of Engineering News

Washington Office Division of Engineering News

FOREST SERVICE ● U.S. DEPARTMENT OF AGRICULTURE

ENGINEERING FIELD NOTES

This publication is a monthly newsletter published to exchange engineering information and ideas of a technical or administrative nature among Forest Service personnel. The text in the publication represents the personal opinions of the respective author and must not be construed as recommended or approved procedures, mandatory instructions, or policy, except by FSM references.

This publication is not intended to be exclusively for engineers. However, because of the type of material in the publication, all engineers and engineering technicians should read each issue.

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Each Region has an Information Coordinator to whom field personnel should submit both questions and material for publication. The Coordinators are:

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Coordinators should direct questions concerning format, editing, publishing dates, etc., to Fran Owsley, Editor, Division of Engineering, Forest Service, USDA, Washington, D. C. 20250.

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ACCELERATED DETERMINATION OF CONCRETE COMPRESSIVE STRENGTH

By H. Robert Young
Supervisory Civil Engineer, Region 1

INTRODUCTION

Standard concrete practice presently includes the making of concrete test cylinders and the breaking of these cylinders after curing for 28 days. A major drawback of this practice is that 28 days is too long to wait for results if they are to be used as the basis for acceptance or rejection. A recently adopted American Society for Testing Materials (ASTM) test method: *C 684, Making, Accelerated Curing, and Testing of Concrete Compression Test Specimens,* seems to cut down on this required waiting period. This test method allows for accelerated curing of the concrete cylinders by three different methods: warm water, boiling water, and autogenous. The cylinders are then tested in compression within 1 or 2 days depending on the method selected. Strength results are therefore available at least 26 days earlier than normal.

Of the three methods, the autogenous method is probably the most adaptable to Forest Service use. It requires thermally insulated curing containers but no external heat source as with the other two methods. These autogenous curing containers are the only additional items of equipment required under this method.

INVESTIGATION

During August and September 1973, a field trial of the autogenous curing method was performed by Bill Antonich and Bob Young of the Regional Materials Group. Two pairs of cylinders were taken from each of 16 batches of Class AA concrete used in the South Fork Flathead River Bridge, Flathead National Forest. One pair of cylinders from each batch was cured by standard procedures and broken at 28 days. The other pair was cured by the autogenous method and broken at 49 hours.

Figure 1 shows the comparison of the standard 28-day strength with the 49-hour strength after autogenous curing. Compressive strengths of pairs were averaged before plotting. Also shown on Figure 1 is a line representing the correlation between 28-day strength and 49-hour strength as determined by the Ontario Department of Highways in extensive research on the autogenous curing method. This line, with the formula $R_{28} = 1.35 R_A + 1180$, is a good fit to our data. There appears to be good correlation between the two methods. Ontario found that this correlation was valid for a wide range of cement types and water/cement ratios, although this correlation may not be valid for all possible mixes.

USE OF THE AUTOGENOUS METHOD

Our present contract specifications would not allow the use of the autogenous curing method as the basis for acceptance or rejection of concrete. However, the method could be used in conjunction with standard 28-day tests to obtain a much earlier indication of ultimate concrete strength. With time, it may be possible to change the specifications so that the autogenous curing method can be used as the standard method for determining concrete compressive strength.

The Regional Materials Laboratory in Missoula has 10 autogenous curing containers capable of curing 20 concrete cylinders simultaneously. These curing containers are available for loan to Forests. Also available for loan are two complete sets of equipment for curing and breaking concrete cylinders by the standard method. These sets include a *Curamold* curing box, compression testing machine, capping device, capping compound, warming pot, ladle, and calipers. This equipment requires a 110-volt power source.

One disadvantage of the autogenous method was noted during the investigation. When concrete was placed on Thursdays or Fridays, weekend work was required to cap and break the cylinders. Ontario suggests that other correlations could be derived for longer curing periods, but this has not been done to date.

The trial use of the autogenous curing method as detailed in ASTM C 684 is recommended for Forest use.

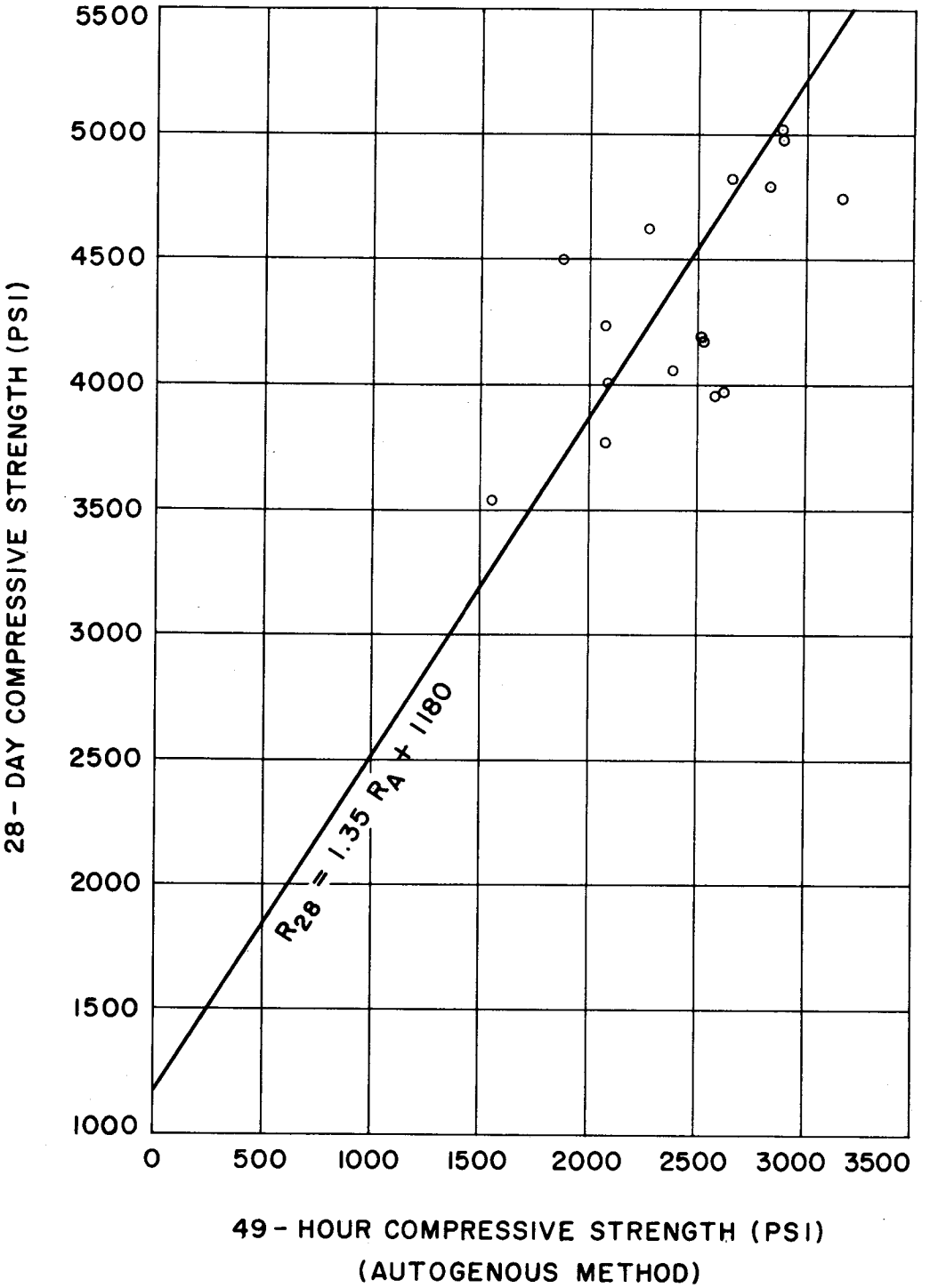

Figure 1. – Comparison of 28-Day and 49-Hour Concrete Compressive Strengths of Class AA Concrete used in S Fork Flathead River Bridge

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COLOR INFRARED FILM DEVELOPED TO A NEGATIVE?

By Alan Koch
Aerial Photographer, Region 6

A new and highly useful form of color infrared aerial photography is providing many benefits to the Pacific Northwest Region of the Forest Service. The new tool is Kodak Aerochrome Infrared 2443 aerial film which has been developed to a negative rather than a transparency. (Although this film was designed to develop to a transparency, several aerial film processing laboratories now have the necessary technology to offer this negative development service.)

Color infrared transparency (CIRT) aerial photography is well known for its value to the interpreter in studies of plant diseases, timber inventory, geology, hydrology and many other areas. In the transparency form, however, it has not effectively met the needs of the photogrammetrist or cartographer. The film diapositives and paper prints needed by these professions have required costly reproduction processes such as reversal printing or the use of an internegative. Now, with the advent of a color infrared negative (CIRN) aerial film, it is possible to produce relatively inexpensive direct color or black and white prints and diapositives. CIRN has created the first opportunity for the interpreter, photogrammetrist and cartographer to all make efficient use of a color infrared aerial photo flight.

With CIRN, the interpreter has the choice of using either color infrared diapositives or color infrared prints in his studies. The color infrared diapositives will provide him with a tool that is operationally similar to that of CIRT. A viewing light table and special stereoscopic equipment, such as an Old Delft scanning stereoscope, will be needed.

The color infrared prints, on the other hand, can be viewed with a simple pocket stereoscope and without the need of a light table, which is especially important to the person who takes his photography into the field. Not only is the print easier to view stereoscopically, it is also easier to store and to mark upon. Regardless of whether the interpreter uses a color diapositive or color print, he also has the option of using a black and white print as an inexpensive extra print to annotate as he wishes.

Perhaps the most intriguing aspect of CIRN is the ability to vary the diapositive or print's tonal signatures to fit the job at hand. Simple manipulation of filters in the printing process often creates tones which have better interpretation qualities than those found in CIRT. For example, the dark red to magenta portrayal of healthy vegetation inherent in CIRT can be subdued to an orange-brown coloration on the diapositive or a print can be made from CIRN. This coloration, in many cases, provides better differentiation between plant communities. When an overall maroon cast is used, water penetration is greatly enhanced. Other filter combinations remain to be explored but, to date, the orange-brown coloration seems to offer the best all-around usefulness.

Another use of filters in the printing process is that of color correction. CIRT does not allow for correcting changes in time of flight, atmospheric conditions, terrain, or film dye changes due to age – only an educated guess as to what filtration should be placed on the aerial camera can be used. Even then, changing filtration as terrain or atmosphere changes within a flight line is not possible. Reproductions made from CIRN, on the other hand, can be color corrected frame by frame if necessary.

Photogrammetrists and cartographers find that black and white diapositives and prints made from CIRN are exceptionally fine tools. Due to the haze penetrating ability of color infrared, they display an ideal amount of contrast and clarity. This haze penetration is highly important when photos are taken from above 10,000 feet where atmospheric attenuation becomes critical.

Of interest to the aerial photographer is the apparent increase in film exposure latitude (aerial film speed remains the same) when using CIRN. In contrast with the minimal latitude of CIRT, the increased latitude of CIRN allows much of the under or over exposure to be compensated for in the printing process. Perhaps some of the many color infrared aerial photos that have been damaged by poor exposure could have been saved if the film had been developed to a negative. The reduction of vignetting and sun spot effects are other benefits to be gained when automatic or manual dodging is used in the printing stage.

Photo labs find that CIRN is an easy and satisfying reproducible to work from. Most reproductions made from CIRN, including enlargements, take less exposure time, and therefore less labor, than printing from true color negative aerial film.

While there are some advantages to color infrared transparencies, such as slightly higher resolution and lower initial cost, the ease of interpretation and multipurpose qualities of products made from color infrared negatives have enabled the tool to play a much more active role in the management of our National Forests. Table 1 shows some of the projects on which the Pacific Northwest Region has used color infrared negative aerial photography. Response has been highly enthusiastic and most users preferred the color infrared print. Comments such as "There is much more information available on these prints than we have ever seen on black and white or color prints!" are not uncommon.

A few sample color infrared prints from CIRN are available on loan to interested Forest Service personnel by writing to: Regional Forester, USDA Forest Service, Post Office Box 3623, Portland, Oregon 97208.

Table 1. – U.S. Forest Service Projects Involving the Use of Color Infrared Aerial Film Developed to a Negative

Primary Project Use	Number of Projects	Photo Scale
Land Use Planning	9	1:15,840
Forest Fire Rehabilitation	2	1:8,000
Insect and Disease Inventory	2	1:8,000 & 1:12,000
Photogrammetric Mapping	10	1:3,000
Pollution Study	2	1:6,000 and 1:12,000
Experimental Watershed Study	1	1:10,000
Advanced Logging System Analysis	1	1:12,000
Geological-Water Table Analysis	1	1:15,840
National Recreation Area Study	1	1:10,000 and 1:20,000
Resource Inventory	1 Forest	1:15,840

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REGIONAL DIVISION OF ENGINEERING NEWS

REGION 1

REGION 1 UTILITY CORRIDOR TASK FORCE

Submitted by Frank Mutch, Electrical Engineer

Region 1 is engaged in a long-range planning effort to identify lands suitable for utility corridors.

An electrical engineer (position recently vacated by Frank Mutch) and a transportation planning engineer, Bill Schnelle, are on the planning team which also includes a multiple-use planning forester, Earl Reinsel, and a landscape architect, Tom Hagan.

In-depth, cooperation with Montana State's Energy Planning Division is in progress. Use of computer technology will be extensive. The State is purchasing the latest in optical scanning and digitizing equipment, and the Forest Service will complement the hardware with access to the Government-leased 1108 computer.

The head of Montana's Energy Planning Division, Dr. Albert Tsao, has a software package which is an improved version of similar processes already tested.

Public involvement will be a key. The public, national and local, are being involved in the data selection, gathering, and weighing. The computer will select an optimum location. Various biased approaches can be run, and the variance from the optimum or from another bias will be measurable.

The first priority will be to identify lands suitable for electrical transmission lines. Other utility impacts will be analyzed later using the same process but with some different data and weighing. Once general land areas are identified, the same process can be used for project appraisal with more refinement in data and land area.

This planning effort will have other benefits including a possible common data bank, experience in State-Forest Service project work as a team, and experience with up-to-date technology in a practical application.

Other agencies are interested and involved including the Bureau of Land Management and other States in Region 1.

The Forest Service team has been the catalyst in this effort.

USE OF EMULSIFIED OIL IN STABILIZING NATIVE IN-PLACE MATERIAL

Submitted by Pat Trottier and Walt Shjeflo

This project, a first in the region, is being done on the Nezperce National Forest, Fenn Ranger District in the Selway River Drainage. The elevations range from 1500 feet to 6000 feet. The project involves 5 miles of new construction and 22 miles of reconditioning the existing roadway, with a minimum of reconstruction on the reconditioned portion.

The process being used is the mixing of in-place native material with CMS-2s emulsified asphalt. These roads do not have a gravel surface so our material has a range of texture from 30 percent passing the 200 seive to 40 percent retained on the 3-inch screen. We found that in some sections binder material had to be imported to mix with the larger material.

This process was designed to provide a stabilized base course in a very fragile soil area as the soil is chiefly decomposed granite where a gravel source is unavailable. The reconditioned section was stage constructed and was built as a low-standard log-haul road of which the subgrade is from 14 to 18 feet wide. We are oil stabilizing the top 4-inch layer of the 12-foot width portion of the road. It is necessary to place the material used for this surfacing in a windrow as a traveling pugmill mixer is used. The windrow has a base width of approximately 6½ feet and needs to be placed 1½ feet from the inside shoulder to ensure maneuverability of the traveling pugmill and complete pickup of berm.

The operation includes a customized D-8 cat pulling a pugmill mixer and an oil tank trailer behind the mixer, for a total equipment length of 75 feet. This train travels down the road at approximately 12 to 15 feet per minute.

With this controlled speed plus an oil pressure pump and gauge on the pugmill, the oil is injected and mixed into the premeasured windrow of native material at a controlled rate which, in turn, we computed to give us an approximate percent asphalt by volume. We also measured the berm after the oil and aggregate had been mixed to check our volumes. We realize this is only approximate at best.

Representative samples of our in-place aggregate had been previously taken and our Forest Service materials lab in Missoula had provided us with an adequate mix design. Although our field mix methods were only approximate, the Regional Office lab periodically checked our work by more exact lab methods to confirm that we were operating within a tolerable range of mixtures.

We found that in the finer material we had to over wet the aggregate to get thorough mixing and prevent *balling* of the oil and dust. The over wetting slowed our curing time and we

found it advantageous to allow some curing time in the windrow prior to lay down. Lay down was done with a grader and the rolling was done with both pneumatic- and steel-wheeled machines. Some curing was accomplished during and after lay down by blading and aerating the windrow. Rolling was done until proper compaction resulted. Frequent checks were made with a nuclear gauge during rolling to insure proper density.

We did not get a seal coat on this road this past season because we were weathered out. It is believed that all material mixed and placed should have a seal coat cover within the same construction season. The material being of such a fine texture does not provide the traction of an open graded mix; whereas a seal coat with chips would provide a seal and a texture wearing coarse.

All indications are that the end product will produce an adequate specification road. Certain administrative restrictions dictated the use of in-place material and the use of the traveling pugmill. We believe that a stationary pugmill and placement with a paver would give more exact depth and width control. The final mixed product appears to be a real boon to road building in this general area where good quality rock is not available.

The project will be finished in July or August 1974 and opened for public and logging traffic.

REGION 4

LETTER TO THE EDITOR

(Reference: Volume 5, Number 10,
October 1973 FIELD NOTES–
Dip Design by H. D. Hafterson)

"Hafty" has given Forest Service engineers a rational basis for designing roadway drainage dips. He is to be commended for calling attention to an obscure problem that has evidently, heretofore, been largely ignored. His example should serve as stimulus for others to investigate, in the engineering tradition, things that we often do by rules of thumb, habit, or strictly and solely from experience.

There is one facet of the dip problem that deserves further attention and should be investigated. What are the safety implications associated with a large number of dips built into a roadway that otherwise has a safe operating speed, in the neighborhood of 20 miles an hour? At first glance it would appear that a road of this nature may present unacceptable stopping sight distance restrictions to vehicles operating at this speed. A large number of dips with "holes" in the roadway of from ½ to 1½ feet deep surely must present visibility problems to traffic using the roadway. Perhaps investigation of this facet of dip design and construction will reveal the need for one other design criteria to be incorporated in the design process.

W. H. Valentine

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TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

ED&T FY 74 Program. The Forest Service FY 74 Budget has been finalized and the program assigned to the San Dimas and Missoula Centers. Specific details concerning current projects may be obtained from the recent *Annual Plan and Progress Report.*

ED&T Publications. An ED&T Report on the Skyvan, five Equip Tips and several specifications have been published since our last list appeared in *Field Notes.*

Reports:
Flight Evaluation of Short SC-7 Military Skyvan, ED&T 5700-11, June 1973
Emergency Jacks for Light Trucks, EQUIP TIPS, June 1973
NOMEX Fabric Firefighters Shirt, EQUIP TIPS, July 1973
Trail Traffic Counter Now Available on GSA Contract, EQUIP TIPS, September 1973
Caution: Electric Power Converters, EQUIP TIPS, September 1973
Improving the Durability of Routed Wood Signs, EQUIP TIPS, September 1973

Specifications:
Interim Performance Specification for Cleaning Unit, Rest Room, Slip-on; FS Spec. 2300-003

Interim Detailed Specification for Cleaning Unit, Rest Room, Slip-on for ½ Ton Pick-up Truck; Forest Service Specification 2300-004

Specification for Fly, Tent, Plastic (Nylon Cloth-Vinyl Laminate); Forest Service Specification 5100-31a, Amendment No. 1

Specification for 1-inch and 1½-inch Linen Hose; Forest Service Specification 5100-183e

Interim Specification for Tool, Rake and Cutting; Forest Service Specification 5100-00284a

Interim Specification for Kit, First Aid, USFS Type I, Individual; Forest Service Specification 6170-007

Interim Specification for Kit, First Aid USFS Type II, Small Crew (8 to 10 men); Forest Service Specification 6170-008

Interim Specification for Kit, First Aid USFS Type III, Large Crew (20 to 25 men); Forest Service Specification 6170-009

Interim Specification for Signs, Sheet Metal, Flat; Forest Service Specification 7160-0010.

OPERATIONS

Harold L. Strickland
Assistant Director

Formulation of national direction for the Forest Service FY-76 program-budget has been under way since November 1973. This is a continuation of the evolution in our programming process. A four-member team from a cross section of Washington Office National Forest System has been formed to work on FY-76 national direction. Frank Hammond from Engineering Operations is one of the members.

The FY-76 program process had its beginning in a national meeting in which representatives from all Regions provided critique of the FY-75 program formulation process and suggested format, content, procedural changes, and made input for the FY-76 program objectives. Subsequently, the Director of Engineering, along with other NFS Directors, provided input to the NFS team. This included short-term (5-year) direction based upon current trends, a list of national program activities in order of priority, and a set of targets by which the Regions could predict accomplishment.

The national team then formed tentative national direction and budget format. Preliminary budget advice was sent to the Regions in January 1974 and replies to the Washington Office are expected in April. Regional and Forest input is expected to follow about the same process as for the FY-75 program-budget. Figure 1 shows an eight-step wheel diagram of the ongoing program-budget process. One revolution equals 3 years; therefore, the process would more accurately be shown using multi wheels.

Obviously, the tentative FY-76 program that results from this process will be subject to changes in economic conditions, energy availability, the executive and legislative process, and unforeseen developments. Field input to the budget always provides the basis for final targets, distribution, and adjustments to match available funding.

Engineering activities support the timber, recreation, wildlife, range, and soil-water-air resources. Detailed input for these activities is necessary at all organizational levels.

Final budget will reflect detailed road and trail, pollution abatement, and other activities related to engineering. This requires engineering input from the inception through the final formation of the FY-76 program-budget.

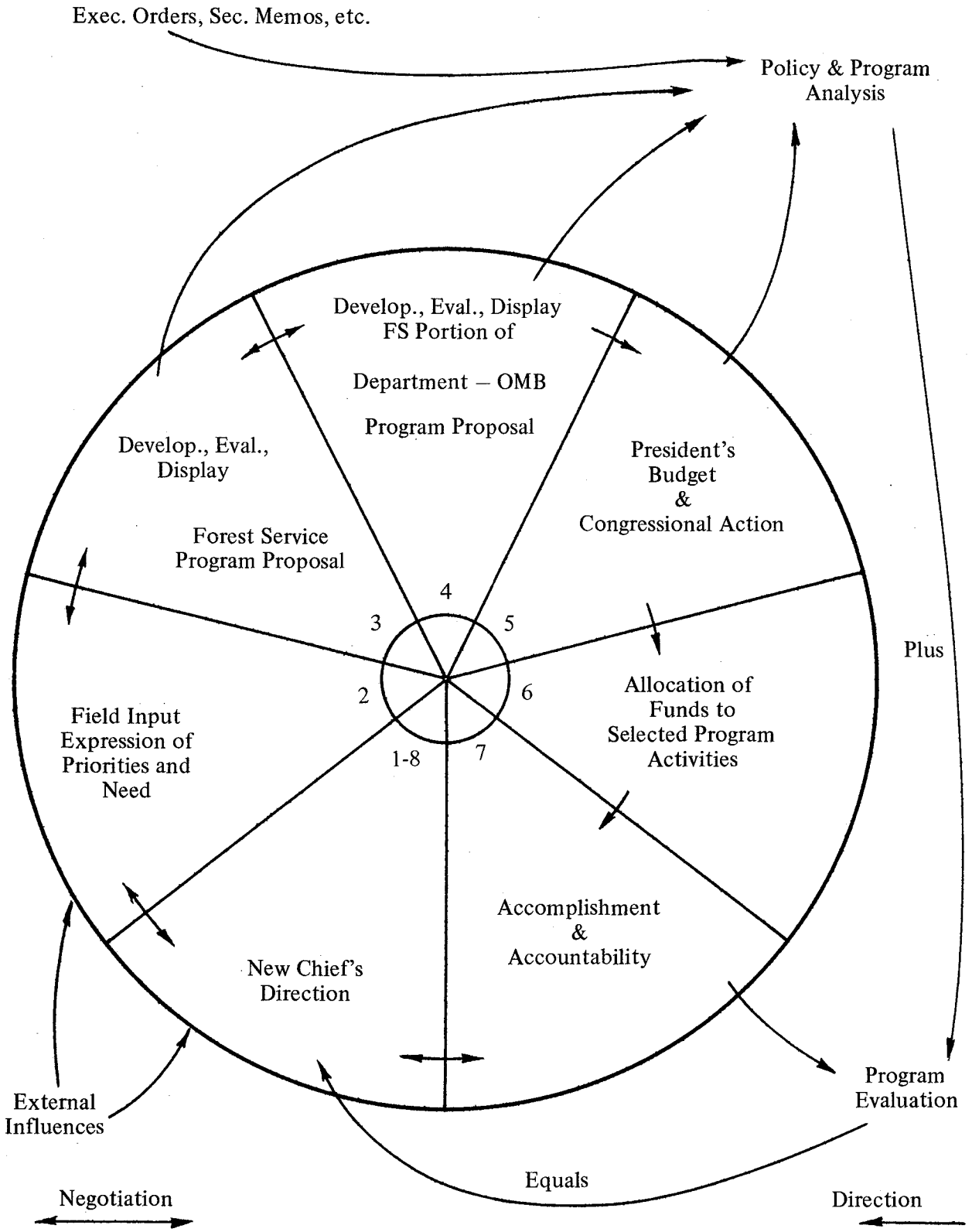

Figure 1. – The Program Budget Process