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NATIONAL ENGINEERING SCIENCE CO PASADENA CALIF
VARIABLE STROKE MECHANISM FOR WAVE FLUME FACILITY. (U)
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DA-22-079-CIVENG-62-46

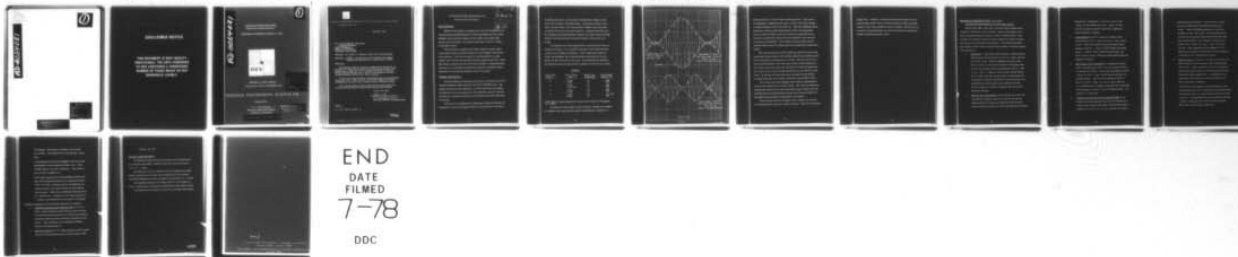
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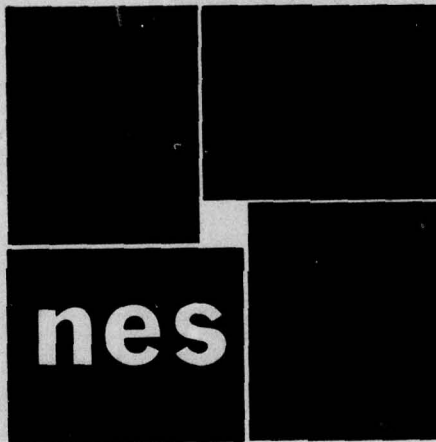
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VARIABLE STROKE MECHANISM
FOR WAVE FLUME FACILITY

MECHANICAL SPECIFICATIONS PA-4-1830



ADDENDA to FINAL REPORT

Contract No. DA 22-079 CIVENG 62-46

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NATIONAL ENGINEERING SCIENCE CO.

Prepared For:

U. S. Army Engineer
Waterways Experiment Station
Vicksburg, Mississippi

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WES Contract Report 2-50-Addenda, June '62

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Addenda nes

NATIONAL ENGINEERING SCIENCE CO. 711 SOUTH FAIR OAKS AVE., PASADENA, CALIFORNIA

Sycamore 5-8461, Murray 1-4686

June 29, 1962

U. S. Army Engineer Waterways
Experiment Station
Corps of Engineers
Office of the Director
Vicksburg, Mississippi

Attention: Mr. Robert Y. Hudson, Chief, Wave Action Section

Reference: WESHH - Contract DA-22-079-CIVENG-62-46(Neg)
Supplemental Agreement #1, Dated June 18, 1962.

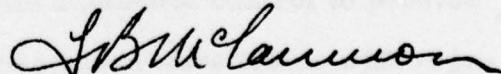
Gentlemen:

In accordance with the reference supplemental agreement, we are pleased to transmit herewith twenty-four prints and one reproducible copy of Dwg. No. PD-4-1824 plus twenty-five copies of Mechanical Specifications FA-4-1830 for the design of a variable stroke mechanism for the Wave Flume Facility.

We are also transmitting one reproducible copy each of drawings PE-4-1687, PD-4-1694, and PE-4-1697 which indicate structural modifications required if the variable stroke mechanism is used.

We trust this design study and specifications will provide the necessary information for constructing this additional facility.

Yours very truly,



L. B. McCammon, Ph. D.
Associate Director of Engineering

LBM:vc

cc: Col. Alex G. Sutton, Jr.

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VARIABLE STROKE MECHANISM FOR
WAVE FLUME FACILITY

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INTRODUCTION

NESCO's Final Report on Contract No. DA 22-079 CIVENG 62-46 provided plans and specifications for both Wave Basin and Wave Flume facilities which permitted change of wave paddle drive speed while system was in operation, but required shut-down of drive for change in the paddle stroke.

The generation of regular wave trains requires remote control of the paddle stroke to provide variation of wave height for the desired wave spectrum. It is also necessary to vary the stroke in a whole number ratio with the wave period to obtain a regular wave train. Since this feature is desired for the Wave Flume Facility, a design study has been made to provide the most practical method for remotely controlling both the speed and the amplitude of the wave paddle.

SYSTEM DESCRIPTION

Various methods for producing wave trains or spectrums were described in NESCO's final report No. DA 22-079 CIVENG 62-46. The system considered most satisfactory for both operational and analytical purposes was a servo-gearmotor with automatic control to provide constant rate amplitude variation for prescribed wave trains with regular periods.

This may be accomplished by replacing the manual handwheel for adjusting the crank arm length as shown on Drawing PD-4-1694 with a

reversible gearmotor, and remotely controlling the rotation of this motor with a program switching device. The program switch is provided with four cams, each representing a definite wave train ratio, or number of waves to each wave spectrum. Regular wave trains are then obtained by synchronizing the rotation of an interval timer through suitable reduction gearing for programming the stroke of the wave paddle.

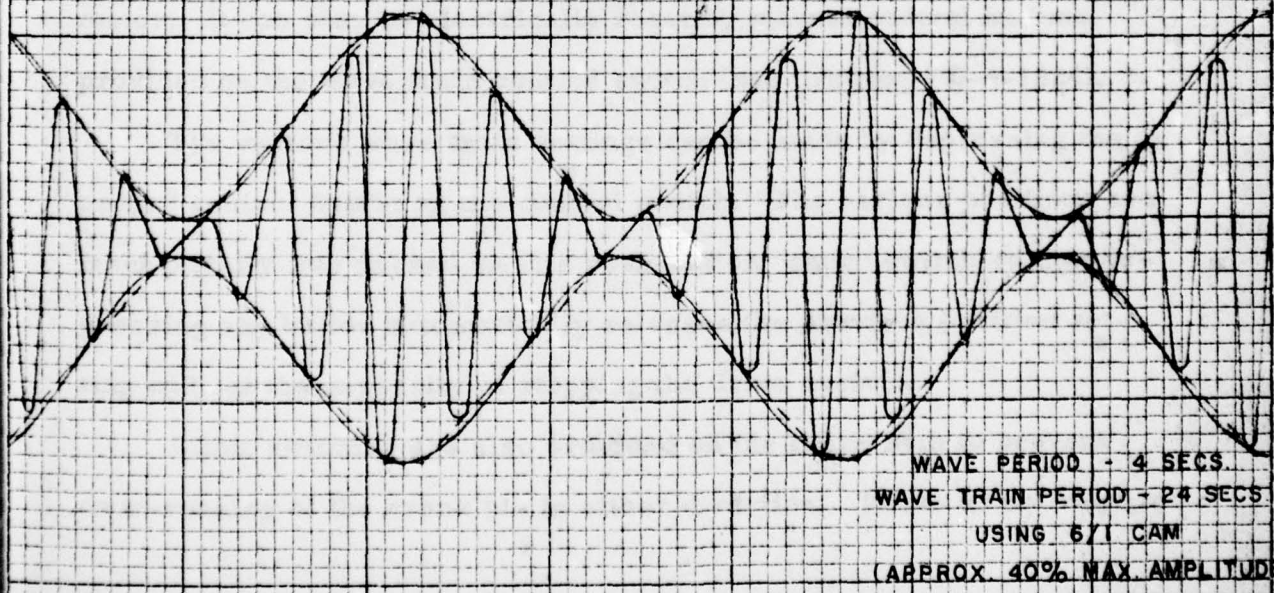
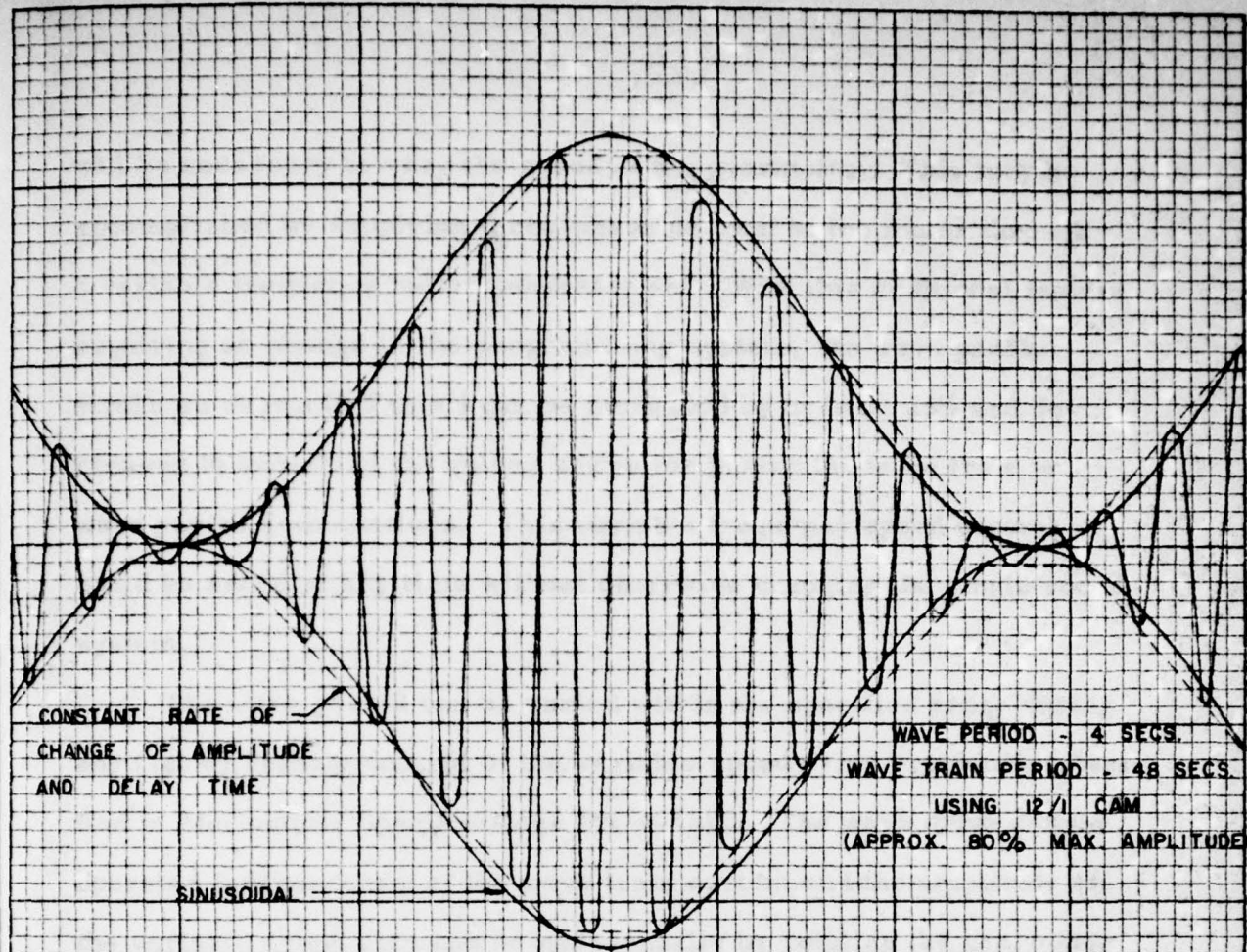
This system will closely approximate a sinusoidal wave train as indicated by Figure 1 for a constant speed gear motor which provides a linear rate of change of amplitude. With a single speed induction motor, the amplitude will be approximately proportional to the wave period and also to the wave train ratio. The following table indicates the operating range and approximate amplitude for the four wave trains.

TABLE I

<u>Wave Train Ratio</u>	<u>Wave Period Sec.</u>	<u>Wave Train Period-Sec.</u>	<u>Wave Paddle Stroke* - %</u>
12	5 max.	60	100%
	1 min.	12	20%
9	5 max.	45	75%
	1-1/3 min.	12	20%
6	5 max.	30	50%
	2 min.	12	20%
4	5 max.	20	33-1/3%
	3 min.	12	20%

*100% stroke is approximately full stroke of the crank arm driving the wave paddle.

If variation of wave paddle stroke to produce variable wave heights for specific wave train and wave period combinations is required, it



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FIGURE 1

will be necessary to vary the speed of the gearmotor. This may be accomplished by supplying three-phase current to the motor through a variable frequency motor generator set. With this additional feature requiring no change in the programming system, the wave paddle stroke as shown in Table I can be increased by at least 25% and decreased to one-third the values shown for particular wave train and wave period combinations. This variable frequency speed control could be added at any time without otherwise changing the single-speed system.

The wave period can be varied within the specified range during any test by remote control of the variable speed drive previously specified in Mechanical Specifications PA 4-1698. The wave drive can be operated independently of the wave train system and the amplitude of the variable crank arm can be set manually by rotating the gearmotor by a small crank or Allen wrench inserted in the rear shaft end of the motor. It can also be electrically reset by manual control buttons provided on the wave train control switch (see drawing PD-4-1824).

The various wave train settings can be made by depressing the proper control button on the control switch. The various positions are mechanically interlocked on this push-button "gang" switch so that depressing any button automatically releases the previous position setting without the necessity of stopping the drive system.

Limit switches are also provided on the crank arm to prevent over-running of the crank pin in either direction. These do not require

manual reset. However, overload protection on the gear motor is provided with manual reset to prevent accident or injury by sudden restart of motor after possible overload condition, which may occur if system is operated during very short wave periods requiring excessive recycling of the gear motor.

MECHANICAL SPECIFICATIONS - PA 4-1830

Variable Stroke Mechanism for Wave Flume Facility

NESCO Dwg. PD-4-1824 shows revisions to the variable stroke crank arm, location of control elements, basic wiring diagram, and also cam specifications for program switch or interval timer. This drawing also indicates functional requirements of all control elements but does not call out specific part numbers. The following specifications identify specific items commercially available to meet the requirements specified:

1. Gearmotor: - Right angle single reduction, totally enclosed, flange mount with hollowshaft for 5/8" o. d. shaft, and also base (side) mount. Shaft end opposite gearhead to have slot or recess for Allen head wrench for turning the motor for very fine manual crank arm adjustment; 1/2 h. p. , 288 r. p. m. , 220 V - 3 phase, 60 cycle motor, Master Frame No. H 56 RW, type PB, normal torque for intermittent reversing duty, equipped with thermal current carrying overload protection with manual reset, supplied by Master Electric Company, Division of Reliance Electric and Engineering Company.
2. Magnetic Reversing Starter for across the line at full voltage with two magnetic contactors, both electrically and mechanically interlocked, but without thermal overload relays (overload protection to be provided directly on motor).

Bulletin 6031, Catalog No. 31A3A for 1/2 h.p. 220V
3 phase, 60 cycle Motor and 125V, 1 phase, 60 cycle
current to operate magnetic contactors, supplied by
Clark Controller Company.

3. Limit Switches (two to be located on variable stroke
crank arm) for 125V, 1 phase, 60 cycle, 1 amp. control
circuit. Industrial enclosed switch with sealed roller-
plunger actuators, 1 - Type F, BAF1-2RQN8-RH (right
hand), 1 - Type F, BAF1-2RQN8-LH (left hand), sup-
plied by Micro Switch, Division of Minneapolis-Honeywell
Regulator Company.
4. Slip-ring and Brush Assembly for mounting on variable
drive, low speed gear, and 6" o. d. hub section as shown
on drawing PE-4-1824. 4 slip rings and brushes for 125V,
1 phase, 60 cycle, 1 amp. control circuit with four 4 ft.
insulated leads. 3 slip rings and brushes for 220V, 3
phase, 60 cycle, 2 amp. for 1/2 h.p. motor with four
4 ft. insulated leads, supplied on special order by the Slip
Ring Company of America, 3612 W. Jefferson Blvd., Los
Angeles 16, California.
5. Multiple Cam Interval Timer (Program Switch), to be
driven from tachometer generator take-off through gear
reducer from variable drive-gear at speeds from approx-
imately 1/3 r. p. m. to 2.5 r. p. m. (see Item 6 for speci-

fications on gear reducer). Timer to have 4 cams, each cam controlling 3 position interval program switch. Interval switching sequence for each cam is shown on Dwg. PD-4-1824. Three position switch for each cam to provide single pole double throw with open center position. All switches or contactors to handle 125V, 1 phase, 60 cycle, 1 amp. for control circuits. This equipment can be supplied by P. R. Mallory and Company, or Electronic Timers Company, a Division of P. R. Mallory and Company.

6. Interval Timer cam shaft is to be driven at exactly one-thirty-sixth ($1/36$) of the speed of the variable stroke paddle drive. This drive take-off can be incorporated with the tachometer generator drive take-off to be supplied with variable speed drive. A multiple step reduction gear is necessary to reduce the speed to the timer cam shaft as specified.

The Interval Timer should be located adjacent to this reduced speed take-off or connected to it by speedometer-type flexible cable, as torque required is not more than 1 inch-lb. A coupling should also be provided to permit setting or resetting of the Interval Timer in proper phase with variable stroke crank arm.

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The Interval Timer should be located adjacent to this reduced speed take-off or connected to it by speedometer-type flexible cable, as torque required is not more than 1 inch-lb. A coupling should also be provided to permit setting or resetting of the Interval Timer in proper phase with variable stroke crank arm.

The supplier for the variable speed drive specified, Reliance Electric and Engineering Company, can supply this extra drive take-off and gear reducer.

7. Control Switch -- A seven-station gang switch assembly is required with mechanical interlock between stations so that only one button can be depressed at a time, and depressing another button releases any other depressed button before the new circuit is made. All buttons to be of translucent material with colored light under each button which remains on for the activated circuit.

The seven station buttons can be hot stamped or engraved with designations as shown on Dwg. PD-4-1824, with figures or letters approximately .2 inches high on 3/4 inch buttons. Designation plates should be provided above wave train buttons (12, 9, 6, 4), engraved "AUTOMATIC," and above "ADV" and "REV" buttons engraved "MANUAL".

Switches and lights for Stations OFF, 12, 9, 6, and 4 to remain energized and lighted after button is depressed. Switches and lights for manual stations ADV and REV to be momentarily energized and lighted only while depressed, and to return to off position when pressure is removed

from button. All switches and lights to be selected for 125 VAC. All switches to be normally open, single pole.

A multi-gang switch with switchlights to meet the above requirements can be supplied by Penar, Inc., 14744 Arminta Street, Van Nuys, California. Their designation for this arrangement is:

Seven station gang switch and switchlight assembly with type D lock and interlocking for all stations but manual "ADV" and "REV" positions which are independent momentary actuated, but which release any other station when actuated. Push button switchlights designated Part No. 1082 NL41W4. Buttons are 3/4" square mounted on 1" centers, and designations can be made as requested.

Additional equipment if Variable Speed Gearmotor is required:

1. Variable Frequency Motor-Generator Set for 1/2 h. p., 220V, 3 phase induction motor normally rated at 60 cps. to provide frequency range of 20 to 80 cps. (Top frequency should be limited to prevent excessive overspeed of gearmotor). This equipment can be supplied by Reliance Electric and Engineering Co.
2. Starter & Control for V. F. motor-generator set to be magnetic non-reversing with thermal overload relays, 220V,

3 phase, 60 cycle.

GENERAL REQUIREMENTS

All wiring for control circuit to be mildew and moisture proof in accordance with NEMA standards and local electrical code for 125V, a. c. , 5 amps.

All wiring for 1/2 h. p. electric motor and magnetic reversing starter contactors to be mildew and moisture proof in accordance with NEMA standards and local electrical code for 220V a. c. , 5 amps.

All equipment mounted on rotating crank arm to be totally enclosed, splash-proof, or otherwise shielded from water splash or drip.

All controls to be mounted on Wave Flume Facility control panel.

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