# EDUCATING PRODUCTION ENGINEERS AND DREDGE OPERATORS ON THE LIMITATIONS OF HYDRAULIC DREDGING USING CUTTER SUCTION DREDGE SIMULATORS

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# ACKNOWLEDGEMENTS


- PETER DEJONG
- SAPE MIEDEMA
- YUANZHE ZHI
- THE MANY DREDGING COMPANIES THAT HAVE SENT THEIR PRODUCTION ENGINEERS AND OPERATORS TO THE SHORT COURSE OVER THE PAST 16 YEARS

# OBJECTIVE & OVERVIEW

- OBJECTIVE
  - DESCRIBE EXPERIENCES IN 2 ½ DAY CUTTER SUCTION DREDGE SIMULATOR SHORT COURSES FROM 2010-15
- OVERVIEW
  - SIMULATORS
  - SCHEDULE & EXERCISES
  - PRODUCTION AND MAIN PUMP GRAPHS
  - PRODUCTION AND PERFORMANCE FOR DIFFERENT EXERCISES BY OPERATORS
  - SUMMARY

# CUTTER SUCTION DREDGE SIMULATORS

Simulator #1

Simulator #2

Simulator #3

# 2 1/2-DAY SIMULATOR SHORT COURSE FOR LARGE (0.61 M) DREDGES

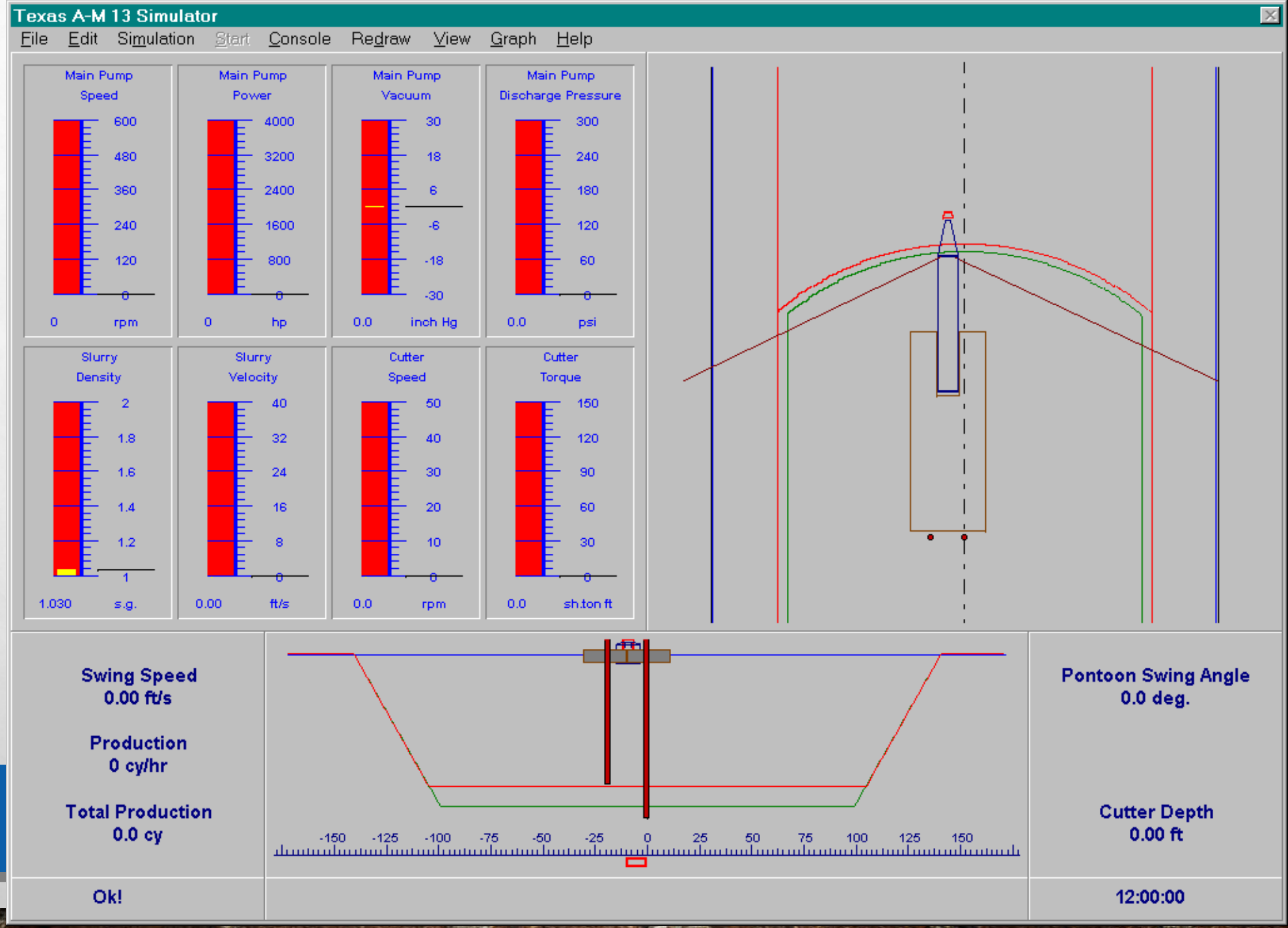
| Time | Large Cutter Suction Dredge Topics |
|---|---|
| | First Day |
| 8:00 – 8:30 | Introduction |
| 8:30 – 9:15 | Dredge Hydraulics |
| 9:15 – 10:00 | Cutting & Dredge Advance |
| 10:00 – 10:20 | Refreshment Break |
| 10:20 – 10:40 | Simulator Scenarios & Files |
| 10:40 – 11:00 | Simulator Demonstration |
| 11:00 – 11:30 | Questions |
| 11:30 – 12:45 | Lunch |
| 12:45 – 1:20 | Simulator Exercise TEXAM 10 |
| 1:20 – 1:55 | Simulator Exercise TEXAM 10 |
| 1:55 – 2:30 | Simulator Exercise TEXAM 10 |
| 2:30 – 3:05 | Simulator Exercise TEXAM 17 |
| 3:05 – 3:40 | Simulator Exercise TEXAM 17 |
| 3:40 – 4:15 | Simulator Exercise TEXAM 17 |
| 4:15 – 5:00 | Review Exercises 10 & 17 |
| 5:00 | Return to hotel |
| | Second Day |
| 8:00 – 8:35 | Simulator Exercise TEXAM 13 |
| 8:35 – 9:10 | Simulator Exercise TEXAM 13 |
| 9:10 – 9:45 | Simulator Exercise TEXAM 13 |
| 9:45 – 10:20 | Simulator Exercise TEXAM 12 |
| 10:20 – 10:55 | Simulator Exercise TEXAM 12 |
| 10:55 – 11:30 | Simulator Exercise TEXAM 12 |
| 11:30 – 12:45 | Lunch |

| Time | Large Cutter Suction Dredge Topics |
|---|---|
| 12:45 – 1:30 | Review Simulator Exercise TEXAM 13 & 12 Results |
| 1:30 – 2:05 | Simulator Exercise TEXAM 8 |
| 2:05 – 2:40 | Simulator Exercise TEXAM 8 |
| 2:40 – 3:15 | Simulator Exercise TEXAM 8 |
| 3:15 – 3:50 | Simulator Exercise TEXAM 14 |
| 3:50 – 4:25 | Simulator Exercise TEXAM 14 |
| 4:25 – 5:00 | Simulator Exercise TEXAM 14 |
| 5:00 | Return to hotel |
| | Third Day |
| 8:00 – 8:45 | Review Simulator Exercise TEXAM 8 & 14 Results |
| 8:45 – 9:25 | Simulator Final Exercise (Your Choice of Dredge) |
| 9:25 – 10:05 | Simulator Final Exercise (Your Choice of Dredge) |
| 10:05 - 10:45 | Simulator Final Exercise (Your Choice of Dredge) |
| 10:45 – 11:00 | Break |
| 11:00 – 11:45 | Review Final Exercise |
| 11:45 – 12:00 | Short Course Critique & Certificate Presentation |

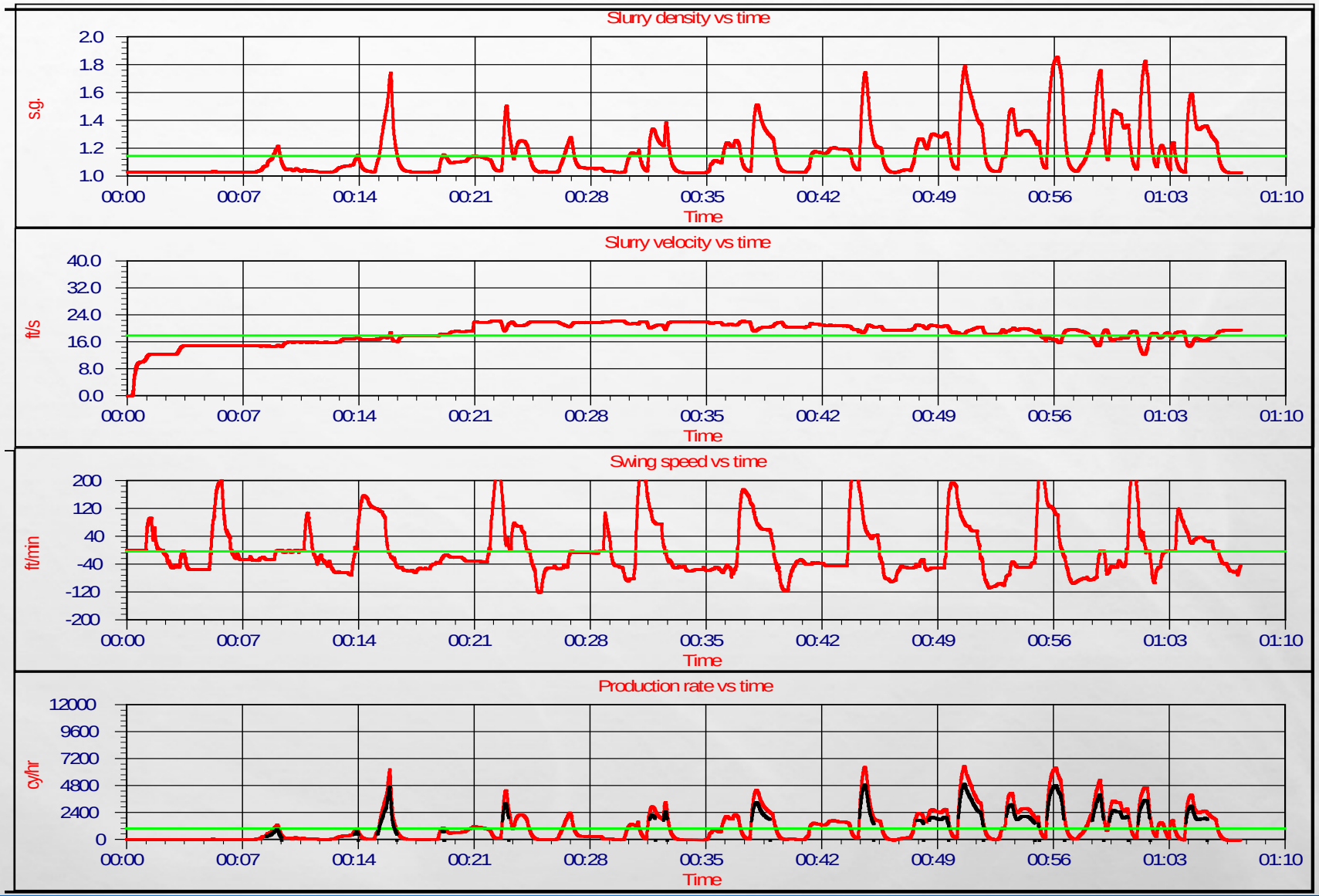
# SUMMARY OF CUTTER SUCTION DREDGE SIMULATOR EXERCISES

| Exercise Number | Suction Diameter | Discharge Diameter | Pipe Length | Advance Method | Sed. | Critical Velocity | Water Depth |
|---|---|---|---|---|---|---|---|
| Small | | | | | | | |
| 21 | 0.30 m (12 in) | 0.30 m (12 in) | 800 m (2624 ft) | Spud Carriage | Med Sand | 3.5 m/s (11.4 ft/s) | 20 m (65.6 ft) |
| 22 | 0.30 m (12 in) | 0.30 m (12 in) | 1200 m (3936 ft) | Spud Carriage | Med Sand | 3.5 m/s (11.4 ft/s) | 20 m (65.6 ft) |
| 23 | 0.30 m (12 in) | 0.30 m (12 in) | 800 m (2624 ft) | Spud Carriage | Gravel | 2.9 m/s (9.5 ft/s) | 20 m (65.6 ft) |
| 24 | 0.30 m (12 in) | 0.30 m (12 in) | 800 m (2624 ft) | Spud Carriage | Med Sand | 3.5 m/s (11.4 ft/s) | 20 m (65.6 ft) |
| 26 | 0.20 m (8 in) | 0.20 m (8 in) | 800 m (2624 ft) | Spud Carriage | Fine Sand | 1.9 m/s (6.1 ft/s) | 20 m (65.6 ft) |
| 28 | 0.20 m (8 in) | 0.20 m (8 in) | 800 m (2624 ft) | Spud Carriage | Med Sand | 2.2 m/s (7.4 ft/s) | 20 m (65.6 ft) |

# DISPLAY ON COMPUTER SCREEN



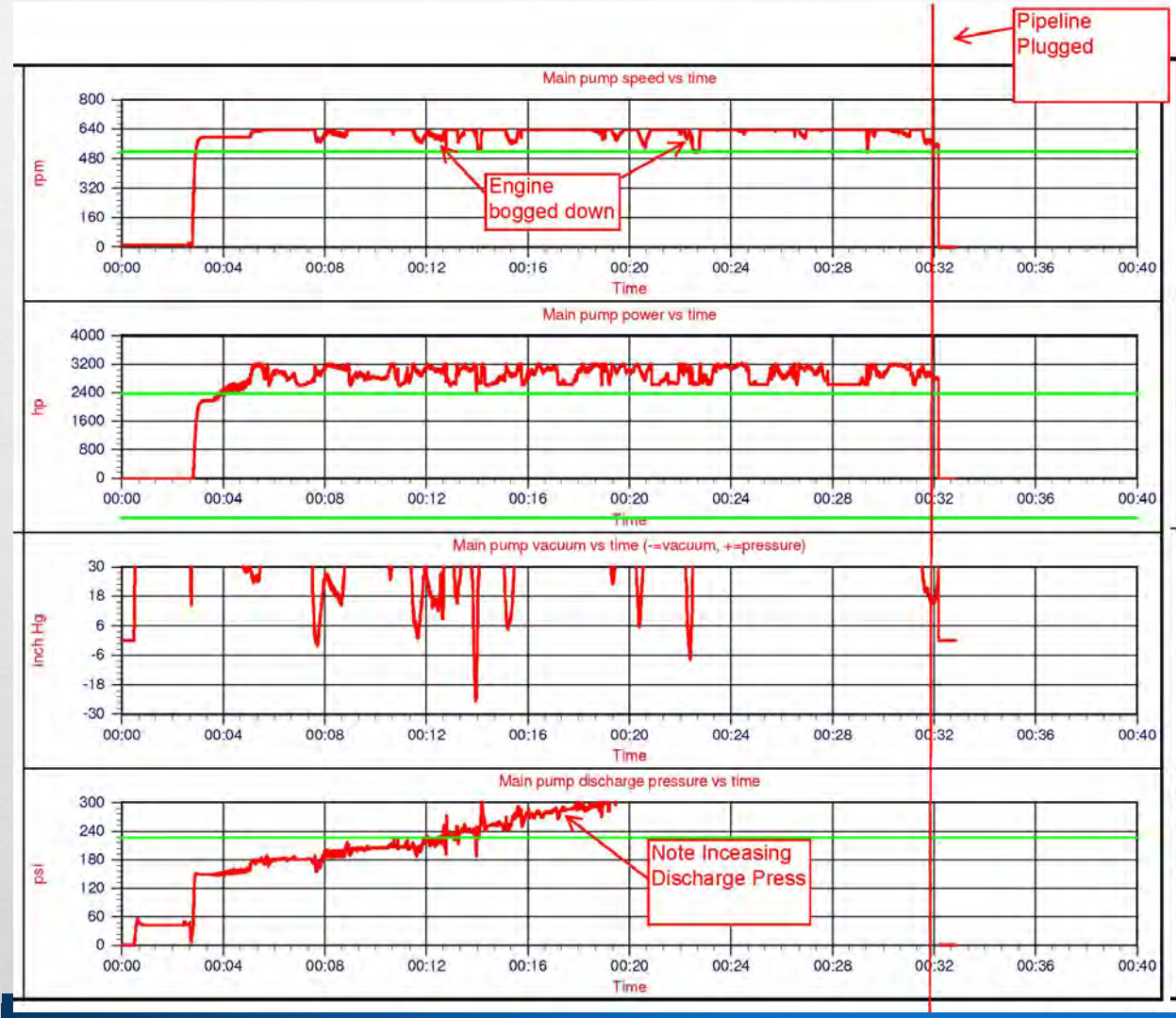
# EXAMPLE PLOTS

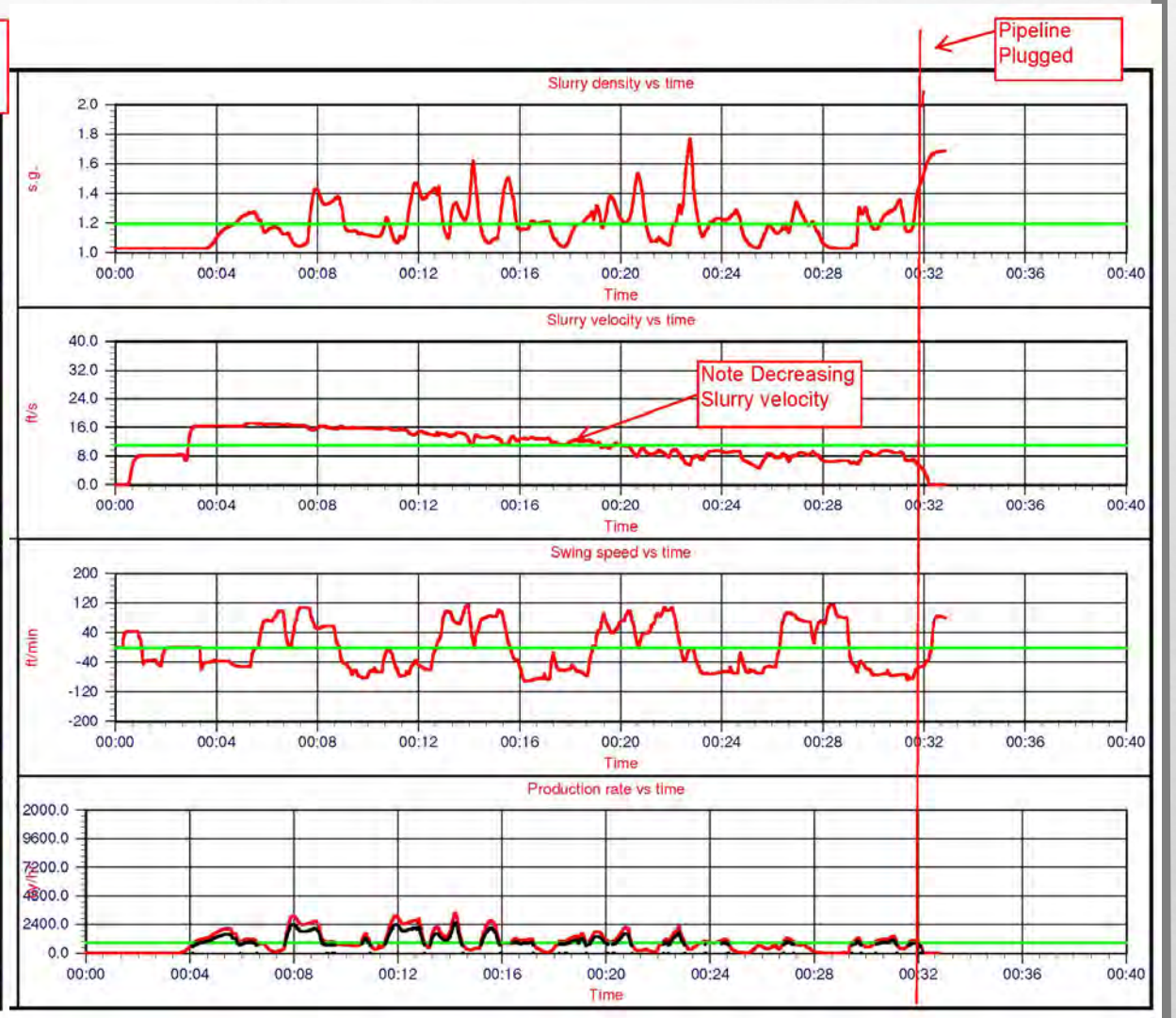


# PARTIAL RECORD OF SIMULATOR COURSE PARTICIPANT ACTIONS

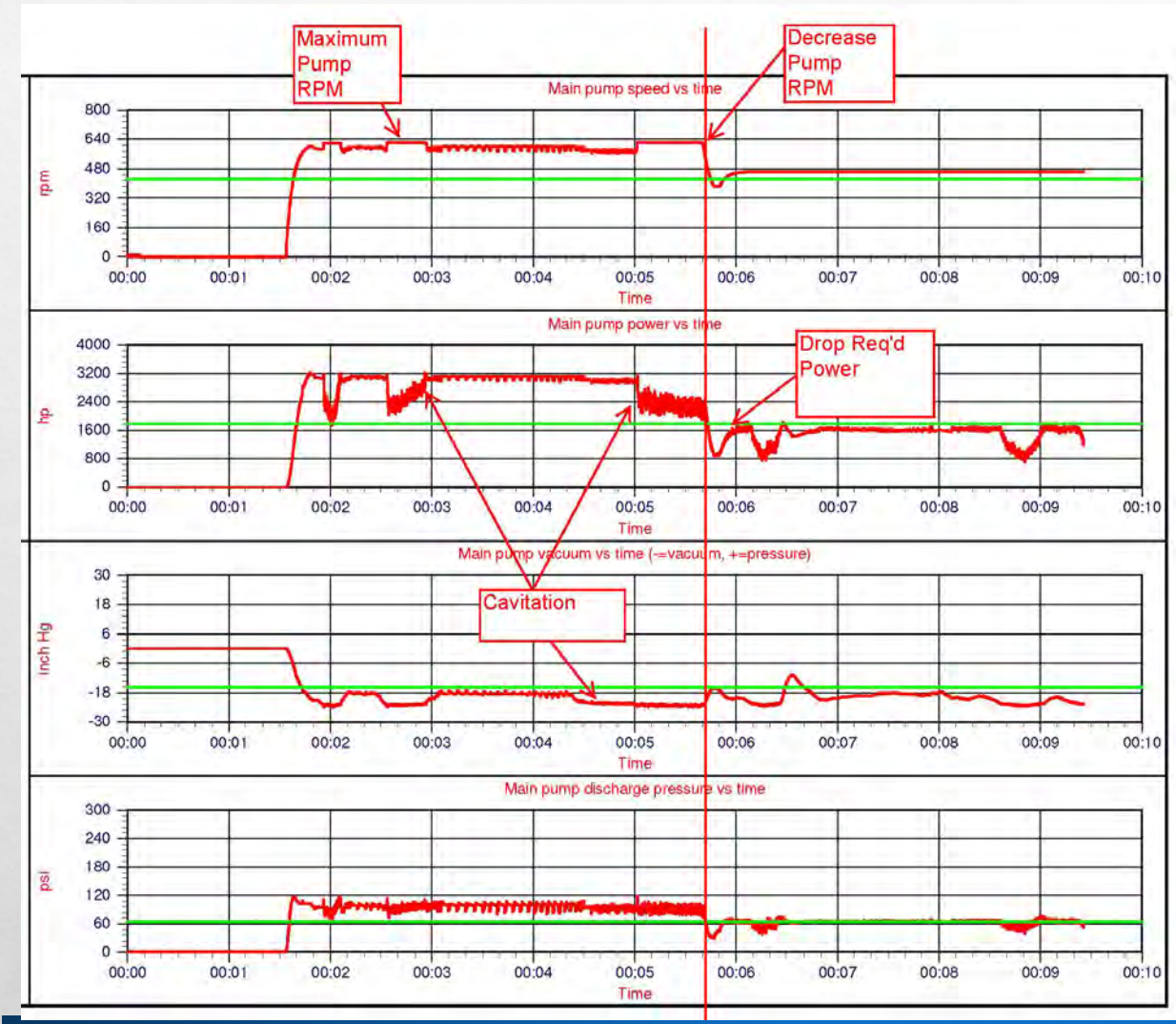
- DATE : 01-05-2000, TIME : 14:57:37, STUDENT: NAME, COMPANY: NAME ID: STUDENT #1, SESSIONS: 1
- 0:00:00 ACTION! START OF SESSION
- 0:00:00 MESSAGE! SUCTION MOUTH ABOVE WATER, STOP CUTTER DRIVE
- 0:00:05 ACTION! MAIN PUMP ENABLED
- 0:00:05 ERROR! SUCTION MOUTH ABOVE WATER, STOP MAIN PUMP
- 0:01:18 ACTION! STARBOARD WINCH IN DUAL OPERATION
- 0:01:27 ERROR! SUCTION MOUTH ABOVE WATER, STOP MAIN PUMP
- 0:01:33 ACTION! LADDER LOWERED
- 0:01:33 FATAL ERROR! PIPELINE CLOGGED
- 0:01:54 ACTION! LADDER HOISTED
- 0:01:59 ACTION! SWING TO STARBOARD
- 0:02:10 ACTION! LADDER LOWERED
- 0:02:11 ACTION! SWING TO STARBOARD
- 0:02:21 ACTION! SWING TO PORT
- 0:02:35 ACTION! FREE FALL OF THE STEP SPUD
- 0:02:40 ACTION! STEP SPUD LOWERED
- 0:02:40 ACTION! WORK SPUD HOISTED
- 0:02:43 ACTION! SWING TO PORT
- 0:03:03 ERROR! MAIN PUMP CAVITATING, RAISE LADDER
- 0:03:14 ACTION! SWING TO PORT
- 0:03:21 ERROR! MAIN PUMP CAVITATING, RAISE LADDER
- 0:03:25 ACTION! SWING TO STARBOARD
- 0:03:32 ACTION! WORK SPUD LOWERED
- 0:03:33 ACTION! FREE FALL OF THE WORK SPUD
- 0:03:34 ACTION! STEP SPUD HOISTED
- 0:03:42 ACTION! SWING TO PORT
- 0:04:00 ERROR! MAIN PUMP CAVITATING, RAISE LADDER

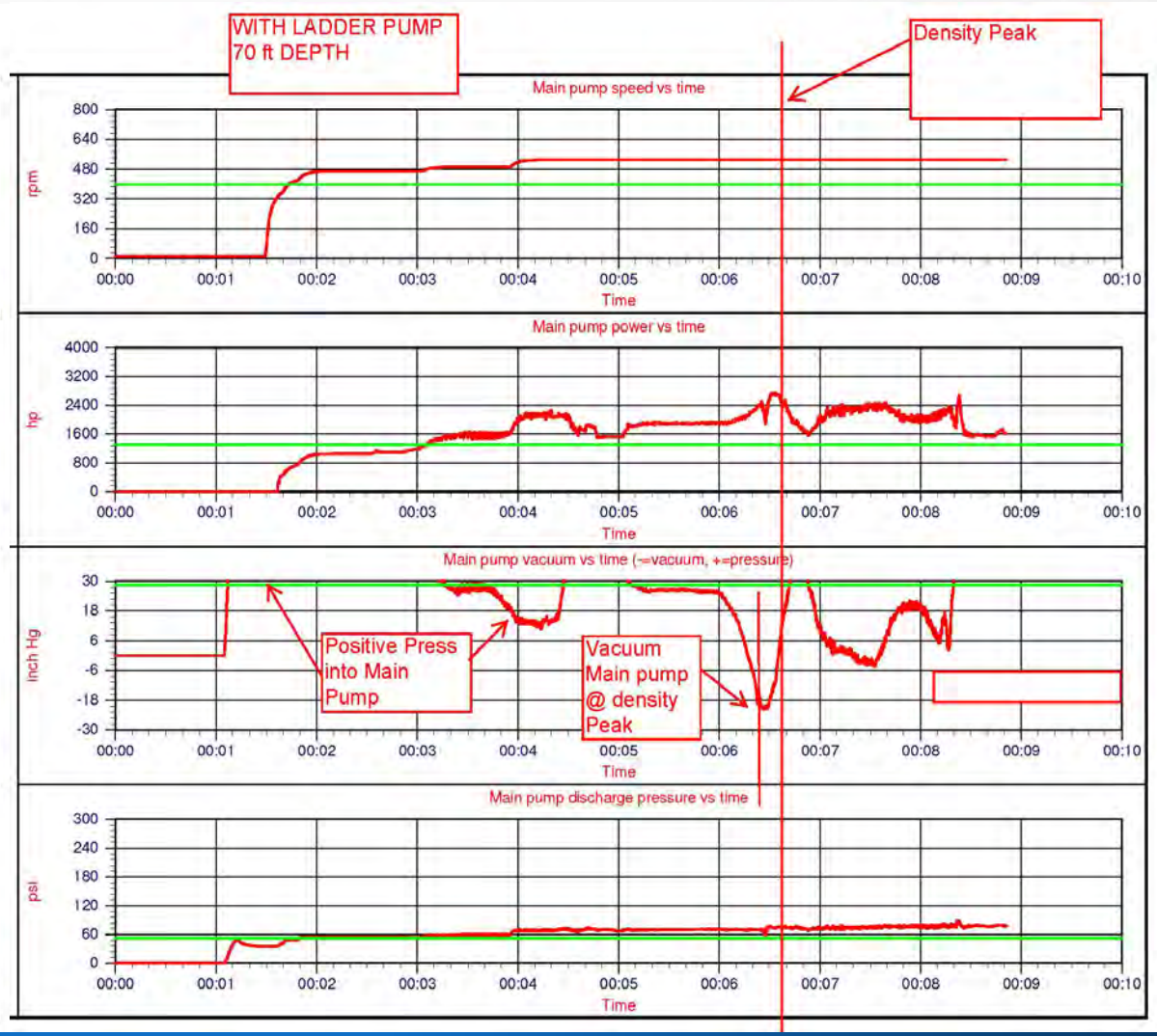
# PRODUCTION AND MAIN PUMP GRAPHS FOR EXERCISE 12 RESULTING IN PLUGGED PIPELINE



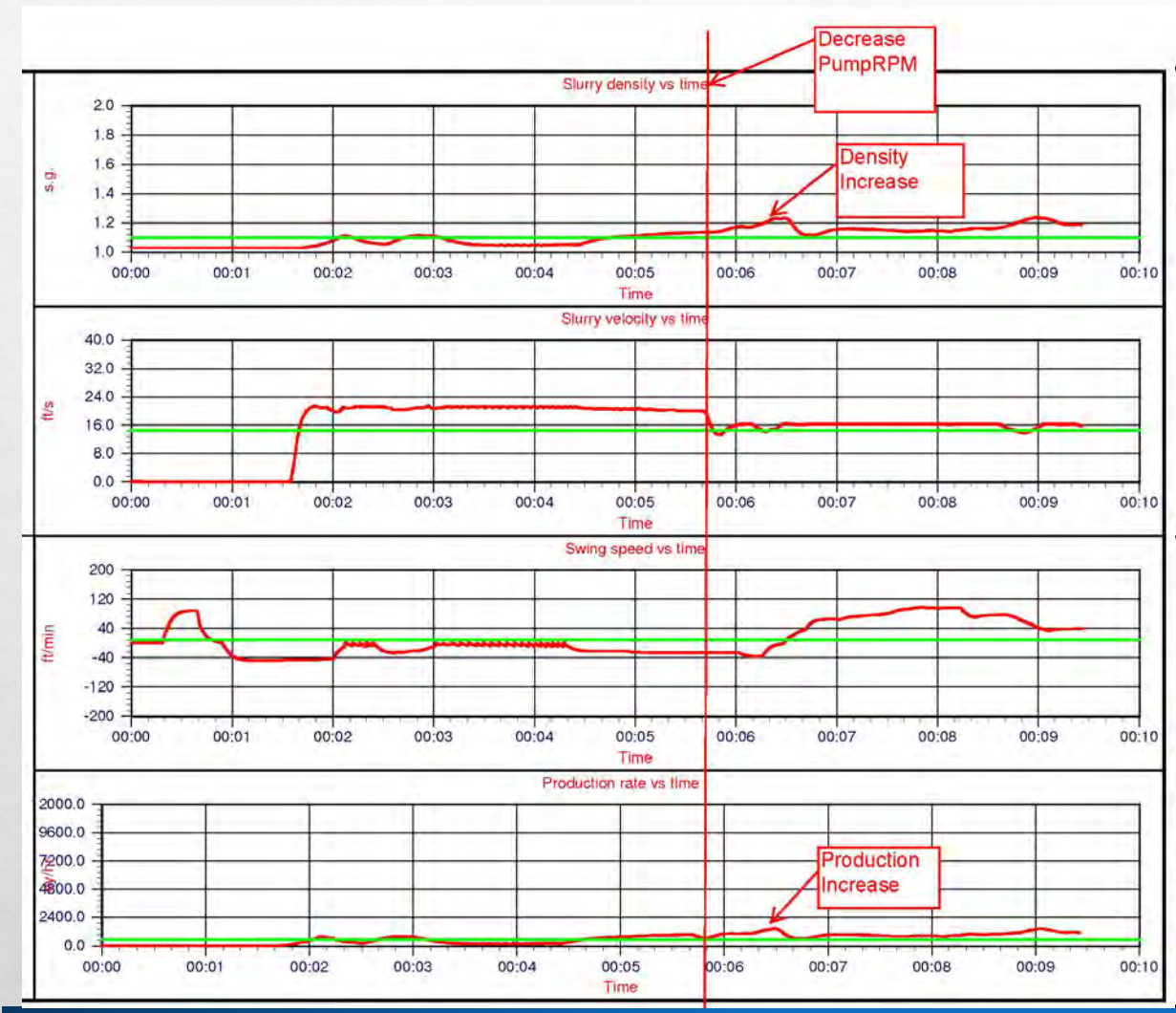



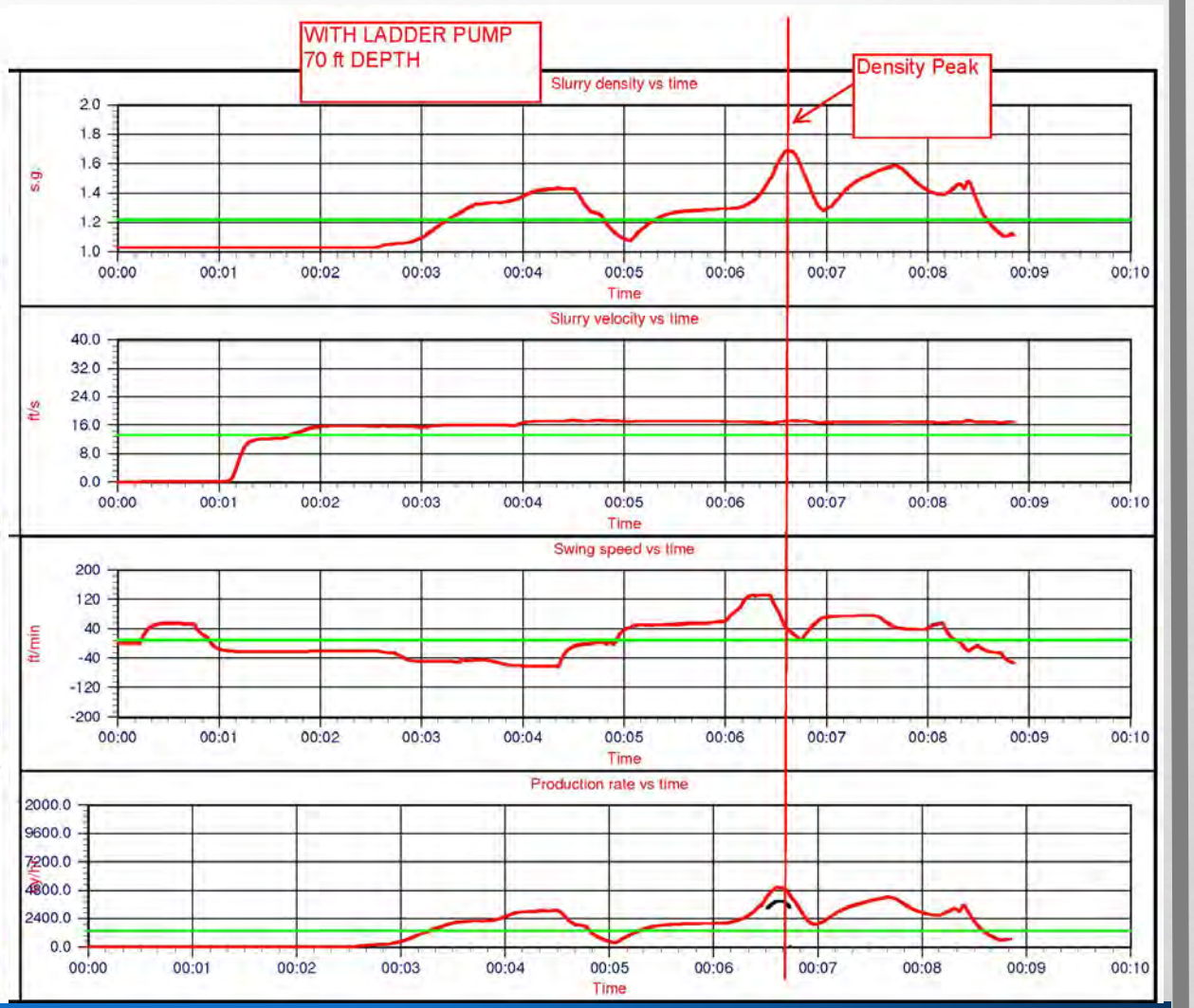
# MAIN PUMP WITHOUT LADDER PUMP (LEFT) AND WITH LADDER PUMP (RIGHT) FOR EXERCISE 8



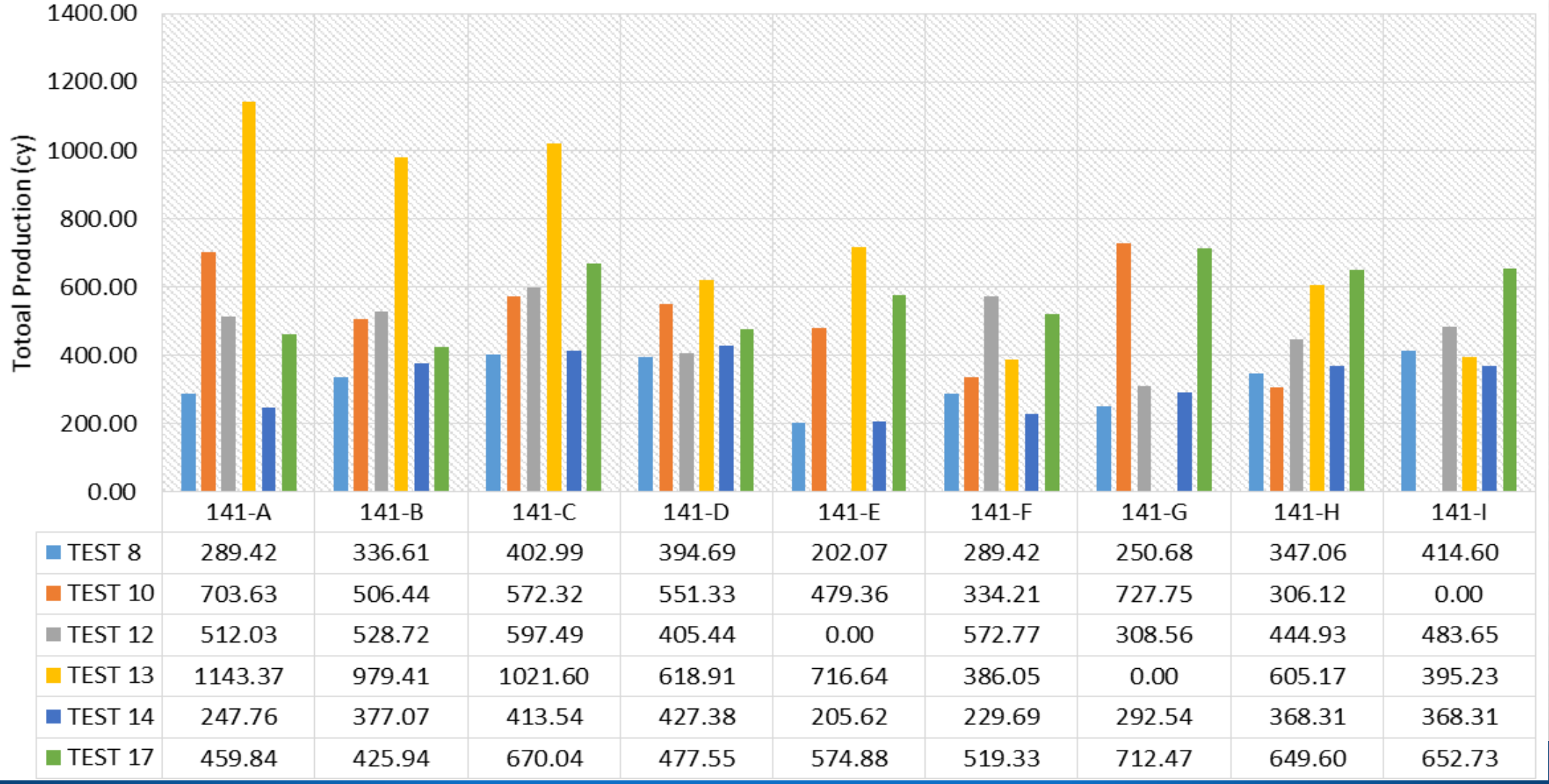



# PRODUCTION GRAPHS WITHOUT LADDER PUMP (LEFT) AND WITH LADDER PUMP (RIGHT) FOR EXERCISE 8



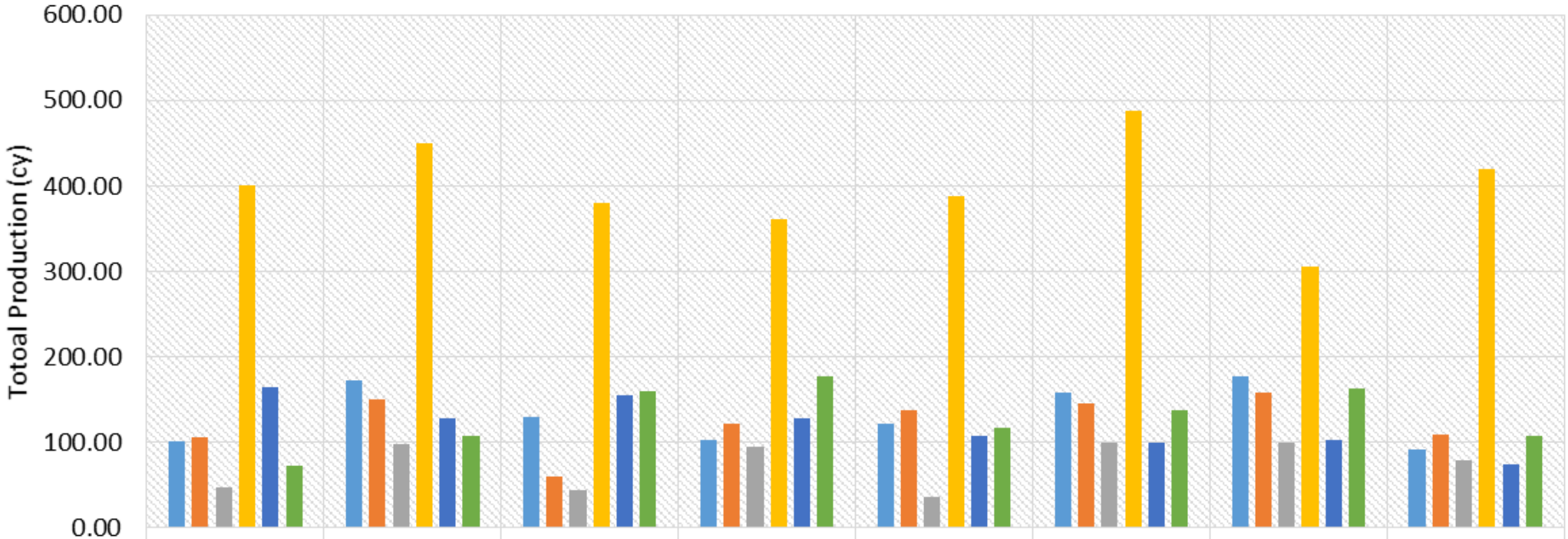



# PRODUCTION FOR THE DIFFERENT LARGE DREDGE EXERCISES



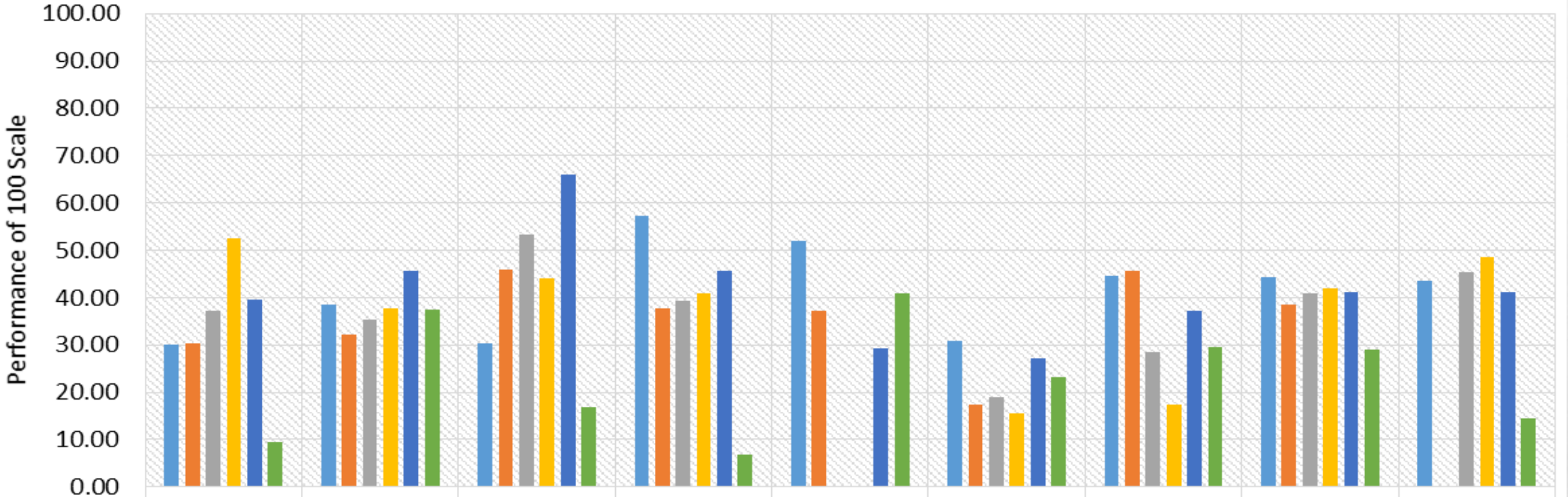

| | 141-A | 141-B | 141-C | 141-D | 141-E | 141-F | 141-G | 141-H | 141-I |
|---|---|---|---|---|---|---|---|---|---|
| TEST 8 | 289.42 | 336.61 | 402.99 | 394.69 | 202.07 | 289.42 | 250.68 | 347.06 | 414.60 |
| TEST 10 | 703.63 | 506.44 | 572.32 | 551.33 | 479.36 | 334.21 | 727.75 | 306.12 | 0.00 |
| TEST 12 | 512.03 | 528.72 | 597.49 | 405.44 | 0.00 | 572.77 | 308.56 | 444.93 | 483.65 |
| TEST 13 | 1143.37 | 979.41 | 1021.60 | 618.91 | 716.64 | 386.05 | 0.00 | 605.17 | 395.23 |
| TEST 14 | 247.76 | 377.07 | 413.54 | 427.38 | 205.62 | 229.69 | 292.54 | 368.31 | 368.31 |
| TEST 17 | 459.84 | 425.94 | 670.04 | 477.55 | 574.88 | 519.33 | 712.47 | 649.60 | 652.73 |

# PRODUCTION FOR SMALL DREDGE EXERCISES



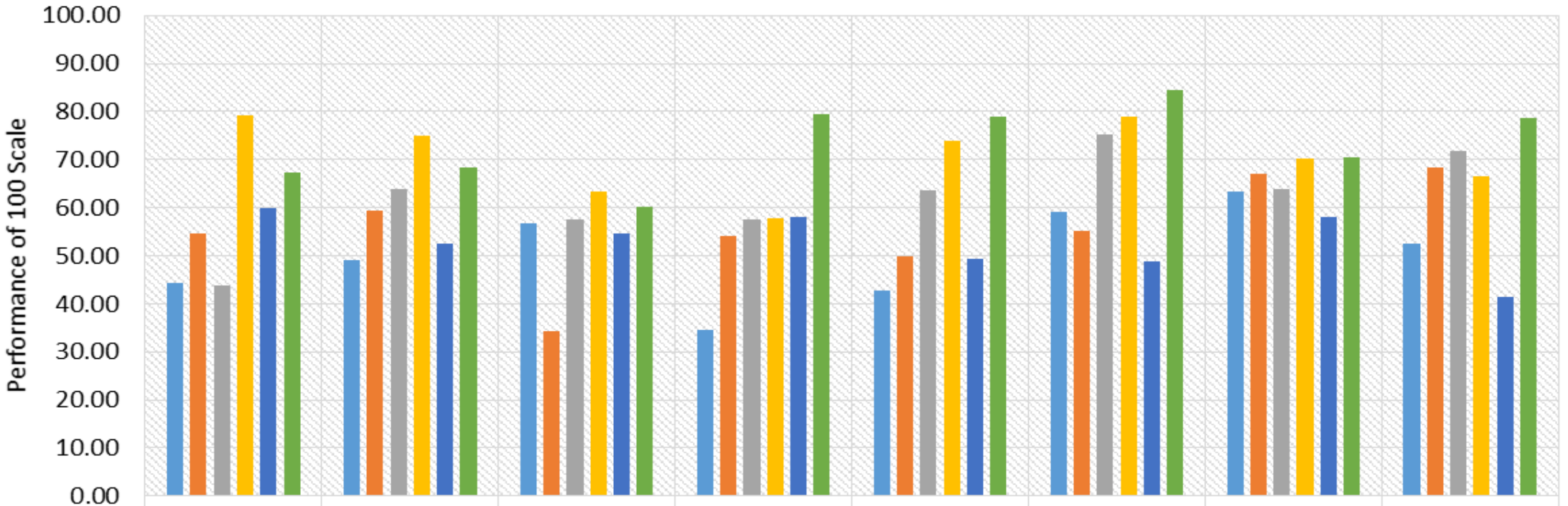

| | 142-A | 142-B | 142-C | 142-D | 142-E | 142-F | 142-G | 142-H |
|---|---|---|---|---|---|---|---|---|
| TEST 21 | 100.54 | 171.88 | 128.92 | 102.49 | 121.47 | 158.48 | 177.26 | 92.19 |
| TEST 22 | 105.10 | 150.18 | 59.50 | 122.20 | 136.98 | 144.71 | 158.42 | 108.38 |
| TEST 23 | 47.88 | 97.32 | 43.28 | 94.43 | 35.46 | 100.00 | 99.17 | 78.94 |
| TEST 24 | 401.23 | 450.26 | 380.26 | 361.12 | 387.83 | 487.43 | 305.49 | 419.96 |
| TEST 26 | 164.91 | 127.89 | 154.77 | 128.39 | 107.86 | 99.44 | 102.16 | 73.81 |
| TEST 28 | 72.03 | 107.81 | 160.05 | 177.84 | 117.72 | 137.45 | 162.40 | 107.74 |

# PERFORMANCE FOR THE DIFFERENT LARGE DREDGE EXERCISES




| | 141-A | 141-B | 141-C | 141-D | 141-E | 141-F | 141-G | 141-H | 141-I |
|---|---|---|---|---|---|---|---|---|---|
| TEST 8 | 30.08 | 38.54 | 30.39 | 57.14 | 52.05 | 30.80 | 44.49 | 44.27 | 43.62 |
| TEST 10 | 30.45 | 32.07 | 45.88 | 37.81 | 37.14 | 17.27 | 45.52 | 38.44 | 0.00 |
| TEST 12 | 37.29 | 35.37 | 53.18 | 39.42 | 0.00 | 19.03 | 28.45 | 40.76 | 45.42 |
| TEST 13 | 52.39 | 37.73 | 43.96 | 40.96 | 0.00 | 15.48 | 17.46 | 41.90 | 48.55 |
| TEST 14 | 39.48 | 45.58 | 66.00 | 45.70 | 29.27 | 27.16 | 37.14 | 41.24 | 41.24 |
| TEST 17 | 9.57 | 37.36 | 16.98 | 6.69 | 41.00 | 23.22 | 29.41 | 28.96 | 14.44 |

# PERFORMANCE FOR EACH PARTICIPANT FOR SMALL DREDGE EXERCISES




| | 142-A | 142-B | 142-C | 142-D | 142-E | 142-F | 142-G | 142-H |
|---|---|---|---|---|---|---|---|---|
| TEST 21 | 44.43 | 49.06 | 56.69 | 34.47 | 42.71 | 59.21 | 63.34 | 52.50 |
| TEST 22 | 54.66 | 59.44 | 34.25 | 54.13 | 49.87 | 55.06 | 66.99 | 68.45 |
| TEST 23 | 43.89 | 63.76 | 57.54 | 57.57 | 63.63 | 75.25 | 63.77 | 71.76 |
| TEST 24 | 79.18 | 74.86 | 63.24 | 57.80 | 73.97 | 78.92 | 70.28 | 66.61 |
| TEST 26 | 60.00 | 52.53 | 54.70 | 58.06 | 49.45 | 48.83 | 57.94 | 41.43 |
| TEST 28 | 67.26 | 68.31 | 60.10 | 79.50 | 78.91 | 84.37 | 70.42 | 78.72 |

# BRENNAN CLASS 2014

# PARTICIPANTS ON SIMULATORS

EXCITEMENT

# CONCLUSIONS AND RECOMMENDATIONS

- SIMULATOR IS A RELIABLE SIMULATION OF ACTUAL CUTTER SUCTION DREDGING OPERATIONS.
- THE EFFECT OF LENGTH OF PIPELINE, LADDER PUMP, CRITICAL VELOCITY, CHANNEL SEDIMENT TYPE, CHANNEL WATER CURRENT, WINCH AND MAIN PUMP POWER LIMITS, AND DREDGE ADVANCE EQUIPMENT ARE DEMONSTRATED.
- THE DREDGE PRODUCTION AND PERFORMANCE FACTORS PROVIDE MEASURES TO SHOW THE EFFECTS OF LONG PIPELINES, LADDER PUMPS, PUMP POWER, AND CRITICAL VELOCITY ON PRODUCTION.
- THE THREE PARTICIPANTS WORKING ON THE SAME SIMULATOR OBSERVE AND LEARN FROM EACH OTHER'S ACTIVITY ON THE SIMULATOR.
- THE REVIEW OF THE DATA AND PARTICIPANT ACTIONS AFTER EACH EXERCISE IS VERY USEFUL IN SHOWING EACH PARTICIPANT THE RESULTS OF THEIR EXERCISE AND THE OTHER PARTICIPANTS.
- THE SIMULATOR HAS THE CAPABILITY TO SIMULATE DIFFERENT DREDGE SYSTEMS AND IN SOME COURSES THE PARTICIPANTS WORKED ON AN ACTUAL COMPANY DREDGE FOR WHICH THE PARTICIPANT IS THE OPERATOR.
- THE PRESENTATIONS ON FUNDAMENTALS OF SLURRY TRANSPORT AND CUTTING OF THE CHANNEL BOTTOM SEDIMENTS PROVED TO BE USEFUL TO THE OPERATORS AND PRODUCTION ENGINEERS.

# THANK YOU

# ANY QUESTIONS