THERMAL PERFORMANCE MEASUREMENTS ON ULTIMATE HEAT SINKS - COOLING PONDS

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U. S. Nuclear Regulatory Commission**

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1. SUMMARY

The Atmospheric Sciences Department of Battelle, Pacific Northwest Laboratories has initiated a data acquisition and analysis program for the Nuclear Regulatory Commission entitled "Thermal Performance Experiments on Ultimate Heat Sinks, Spray Ponds and Cooling Ponds". The primary objective is to obtain the requisite data, with respect to modeling requirements, to characterize thermal performance for nuclear facilities existing at elevated water temperatures in result of experiencing a genuinely large heat load and responding to meteorological influence. The data should reflect thermal performance for combinations leading to worst-case meteorological influence.

A geothermal water retention basin has been chosen as the site for the first measurement program and data have been obtained in the first of several experiments scheduled to be performed there. These data illustrate the thermal and water budgets during episodes of cooling from an initially high pond water bulk temperature. Monitoring proceeded while the pond experienced only meteorological and seepage influence. The data are discussed and are presented as a data volume which may be used for calculation purposes.

Suggestions for future measurement programs are stated, the intent is to maintain and improve relevance to nuclear ultimate heat sinks while continuing to examine the performance of the analog geothermal pond. It is further suggested that the geothermal pond, with some modification, may be a suitable site for spray pond measurements.

2. INTRODUCTION

The purpose of the research reported here is to determine the thermal performance of warm cooling ponds (and eventually, spray ponds) that are proposed to be used as ultimate heat sinks in nuclear power plant emergency core cooling systems. The need is derived from the concern that certain elements of the performance are unknown and that information is required for proper design and the design of performance tests to meet the Nuclear Regulatory Commission criteria. Data, site-specific, but of generic applicability, are required for useful modeling directed toward the specification of design and of performance prediction, [1]*

Ultimate heat sinks for active emergency cooling systems are not available for study so analogs must be identified for actual measurement programs. These include either naturally-occurring or man-made genuinely warm bodies of water as analogs of nuclear facility cooling ponds and spray ponds at various industrial or power facilities.

Measurement and study programs on these analogs require care and experience in staging and implementation. The requisite expertise has been acquired through preliminary measurement effort at a site of convenience (proof experiment - [2]) so that the field programs may be accomplished with expectation of success.

The research reported here is in response to these criteria and ideas. The remainder of the report includes a description of several accomplished and relevant activities:

*The numbers enclosed in [] indicate References.

- indication of proper sites and facilities for field measurement programs on analog systems.
- deployment of an integrated instrumentation system applied to a high-thermal load cooling pond.
- analysis of the acquired data to enable understanding of aspects of site-specific heat transfer processes.
- identification, through experience and expectation, of instrumentation modification and supplementation required for further application in measurement programs.
- presentation, in tabular and graphical form, of a data volume useful for calculations and as a partial base for modeling effort.

3. CONCLUSIONS

The data acquired from the analog geothermal pond characterize the thermal performance and water budget of that pond for meteorological influences experienced during a short period in April-May 1977. The data are site-specific for pond location at relatively high altitude in Southern Idaho. Extrapolation of results to ponds of different sizes and shapes as well as to ponds at other locations and experiencing different meteorology and the relevance to ponds containing currents in either stratified or mixed mode, must be accomplished through modeling effort. The modeling can only be successful if an adequate data base exists by contrast with the present situation of incomplete data and if the physical mechanisms of transfer are adequately understood. More data and analysis are required for useful understanding of cooling pond thermal performance. The same conclusion holds for future consideration of spray pond behavior.

Further measurement programs should be accomplished at the geothermal pond for an array of different meteorological influences and with the pond sealed against seepage, a phenomenon which may interfere with complete data description and integration. It is further concluded appropriate to consider converting the cooling pond to a spray pond to enable collection of the data relevant to spray thermal performance. With this opportunity to continue, and complete, the measurement programs then data volumes of a character suitable for modeling purposes will become available for both cooling ponds and spray ponds.

4. EXPERIMENT PHILOSOPHY

The field experiments are intended to represent heat transfer studies and to result in data which enable budget calculations, identification of transfer mechanisms and their relative and absolute magnitudes, and to form a base for modeling efforts. These heat transfer studies are to be contrasted with, for example, efforts designed in consideration of environmental effects of cooling ponds per se. Further, the water and thermal budget for a cooling pond is determined through the deployment of arrays of rather conventional instrumentation. All possible mechanisms of heat transfer are monitored with the integrated instrumentation system, calculations are performed in a bulk sense for budget purposes. It is not the intent of the effort to develop specialized sensors for measurement purposes.

An ultimate objective of this work is to produce a data base for heat transfer processes which may then be usefully considered in modeling efforts to describe generic cooling pond performance. This will eventually lead to criteria for the assessment of ultimate heat sinks as components of emergency core cooling systems for existing systems as well as in a priori sense for proposed systems. It is required to have a quantitative basis for this assessment in the present absence of such. Indeed, certain engineering criteria are available, however these criteria do not adequately relate to real meteorological influence on heat transfer.

It is appropriate and probably necessary that these studies be done on analogs to real emergency core cooling system ultimate heat sinks. The probability of encountering a designed cooling pond in a thermally active state representative of high heat load conditions is very small. Further, it is not reasonable to expect that operations can be arranged to suit

the needs of a proper measurement program. In addition, safety and security considerations likely eliminate the possibility of making measurements on an operating emergency system.

Therefore, a useful analog cooling pond is chosen to represent the active emergency pond. The first criteria for selection is the presence of a reasonable quantity of genuinely warm water. Secondly, there should be some availability of flexibility in pond operation so as to produce various conditions for thermal assessment, i.e., the analog pond should be studied through cooling from an elevated bulk temperature. Thirdly, the analog pond should be of such character that all relevant heat transfer mechanisms can adequately be quantitatively assessed. In addition, assessment of the analog pond should occur for various meteorological conditions.

Conclusions from this data collection effort must be relevant to the NRC criteria of performance, [3]. These relate to worst combinations of controlling parameters for the cases of water budget (for cooling ponds through evaporation) and for thermal budget. Considerations are based on time scales of 1 day, 5 days and 30 days and their combination. In result, the measurement programs are designed to enable quantitative assessment of all relevant heat transfer mechanisms over time periods sufficient in duration to allow extrapolation, based firmly in the data and physical principle, to the time scales associated with the criteria.

5. SITE AND COOLING POND DESCRIPTION

The Idaho National Engineering Laboratory is conducting geothermal research and development activity for the Energy Research and Development Administration at sites in Southern Idaho. One of these sites (Raft River) is located near Malta and is partially illustrated in Figure 5.1; although small quantities of hot water flow naturally from springs, deep wells have been drilled to provide large quantities of geothermal water for various experimental purposes. The site is operated by EG&G - Idaho, Inc. for ERDA; the enthusiastic cooperation of EG&G personnel is appreciated and recognized as important to the successful measurement program conducted by Battelle.

The reserve pond, located adjacent to Well No. 2 in Figure 5.2, was chosen as a useful measurement site by Battelle personnel during a visit to Raft River in December 1976. Of three ponds available at Raft River, the No. 2 pond was chosen primarily on the bases that the configuration provided least obstruction to winds and that the best opportunity existed for a successful measurement program because of minimal logistics problems. The spray pond and the fish tanks, illustrated in the figures, were dismantled prior to the measurement period. Irrigation of crop plots has not been detectable in the data acquired during the thermal performance measurements. The almost-square pond is oriented at 45° with respect to the cardinal compass directions. Water is received by the pond from Wells 1 and 2 (pump assisted) and may be pumped from the pond to nearby fields as required for either irrigation or disposal in excess of seepage. EG&G personnel maintain weather and environmental data collection systems in a small building located away from and Northeast of the pond. Battelle's choice of the No. 2 pond was described to personnel of the Nuclear Regulatory Commission at Silver Spring, MD during February 1977 and concurrence was obtained for an April-May measurement program at the site.

Figure 5.1 An approximate plan of the Raft River Geothermal Site No. 2. The various items are identified in the figure, the biological and spray experiments were dismantled prior to thermal performance measurements. (From an EG&G drawing).

Figure 5.2 Three research and development sites at Raft River. The thermal performance measurements were made at Site No. 2. Distances between sites are sufficient that they do not interact thermally through the atmosphere. (From an EG&G drawing).

The basin was scraped out of sand and gravel by bulldozer; the bottom configuration is that of a bowl in the "East" - "West" direction with gradually sloping ends and flat in the "North" - "South" direction terminating in essentially vertical banks. Figure 5.3 shows a bottom topography, obtained by using a calibrated stick from a small rowboat deployed on warm water of constant surface elevation. Registration of surface elevation with respect to instrumentation heights was determined through use of a surveyor's level and rod, variation of surface height, due to seepage and evaporation, was monitored through reference to a meter stick attached to a fence post driven into the pond bottom.

Because of the basin asymmetry, the "North" and "South" shores are nearly vertical banks with elevation approximately 1.5 m above the pond surface, the "East" and "West" shores have gradual slope. Changing surface area, in result of changing surface elevation, is small (a maximum of 5% for a 72-hour period) but has been taken into account for the sample calculations contained in this report.

Nominal pond surface area is 3200 m^2 , the calculated nominal volume is 4300 m^3 . The range for these quantities is from 3277 m^2 to 3099 m^2 for area and from 4829 m^3 to 3740 m^3 for volume (due largely to seepage which was determined to be an order of magnitude larger than evaporation) for a 72-hour period of measurements. The corresponding surface elevation change is approximately 0.5 m (53 cm) and does not significantly affect the representativeness of data obtained from fixed onshore instrumentation.

Terrain in pond vicinity is essentially flat with a mound of sand and gravel of 2 m elevation above grade at the "West" end of the pond, the mound gradually slopes toward the pond as an artifact of the bulldozer operation. Mountain ranges rim the Raft River Valley at distances of kilometers from the site

Figure 5.3 Representative values of pond depth (m). The "East" and "West" ends gradually slope to shore, the "North" and "South" ends terminate in sharply sloping banks.

and with elevations of approximately 1 km above site elevation. There exist no major immediate obstructions to wind, a small wellhead building is located away from pond edge on the "South" side, barbed wire and chain-link fences enclose the pond area but provide no discernable obstacle to flow.

Site elevation is 1477 m (MSL), during the measurement period surface atmospheric pressure was observed to range from 839 to 856 mb. General weather conditions prevailed ranging from clear, cool, and fair days and nights to periods of rain (one to two-hour showers of moderate intensity). In addition, periods with dust-laden air were experienced with gusts of wind to approximately 30 ms^{-1} . On occasion, during warm after-noon conditions, large dust devils were observed to the East, but well-removed from the site. Figure 5.4 illustrates annual wind roses for the pond site and the valley vicinity. With very limited fetch over water, for maximum wind observed, waves on the surface were found not to exceed 5 cm in amplitude.

Geothermal water from wells No. 1 and 2 was used to fill the pond for the thermal performance measurements. Chemical analyses for both sources are listed in Table 5.1 along with data for comparison from other sources. Casual observation showed no evidence of any biological activity in the pond water; there was a complete absence of algae in the pond, the water appeared clear with no indication of any kind of a surface film. The absence of a surface film is a required condition for representative heat and moisture transfer at the water-air interface. The water has been shown to be useful in the rearing of fish with the benefit that it contains no disease organisms.

Water and steam is supplied to the pond at a temperature approximately 150 C; EG&G personnel constructed a pipe terminating below the pond surface, at Battelle request, so that essentially all of the heat contained in the mixture could be

Figure 5.4 Wind roses (annual) for the No. 2 site and for other sites nearby. Site separation is approximately 20 km, the very different direction distributions are due to the mountain ranges. (From an EG&G drawing).

Table 5.1. Chemical concentrations in the geothermal water.
The No. 2 pond was filled with water from RRGE-1
and RRGE-2. (Data supplied by EG&G).

Chemical Species	RRGE-1		RRGE-2		RAFT RIVER	
	$\bar{X}$	S_x	$\bar{X}$	S_x	$\bar{X}$	S_x
CL ⁻	776	184	708	70	153	70
F ⁻	6.32	1.47	8.25	1.06	0.65	0.21
Br ⁻	<1.5		<1.5		<1.5	
I ⁻	0.036	0.003	0.028	0.019	0.066	0.016
*HCO ₃ ⁻	63.9	20.8	41.3	11.2	172.5	45.0
SO ₄ ⁼	60.2	6.7	54.1	5.1	55.2	28.0
NO ₃ ⁻	<0.2		<0.2		3.8	<0.2
Total						
NH ₃	1.56	1.19	0.60	0.41	1.0	
Total						
P	0.023	0.014	0.020	0.011	0.038	0.028
S ⁼			0.256			
Si(OH) ₄	182	33	201	40	40.4	21.0
Si	56.6	16.7	61.2	14.5	18.7	1.5
Na	445	99	416	44	77	26
K	31.3	7.0	33.4	5.3	7.7	0.7
Sr	1.56	0.35	1.03	0.32	0.52	0.16
Li	1.48	0.40	1.21	0.57	0.04	0.01
Ca	53.5	9.5	35.3	8.7	85.3	29.6
Mg	2.35	2.09	0.58	0.80	23.9	9.8
pH					7.94	0.15
Total Dissolved Solids	1560		1267			
*Conduc-tivity	3373		2742			

*HCO₃ Concentrations are recorded in µg/mL as CaCO₃

*Conductivity is recorded in µmho/cm

transferred to the pond. In this way, the pond was filled with water bulk temperature approaching 50 C from approximately half volume to full volume in about 30 hours. In a short time, within an hour after filling, the pond achieved its permanent equilibrium condition, fully mixed due to small-scale convective activity. Inspection showed the water to be clear, overlying a dark brown mud bottom.

6. INSTRUMENTATION

Instrumentation systems were deployed to assess the thermal performance of the pond as it lost heat and water to the surroundings. Sensors were placed in the pond water and in the air above and surrounding the pond surface. Other instrumentation was utilized to assess and monitor the general ambient atmospheric conditions and processes. Additional information was available through meteorological and environmental monitoring by EG&G.

6.1 In-Water Sensors

Thermistors were placed in the pond to provide temperature information continuously through the measurement periods. These sensors (YSI 44006 and YSI 44106, 10K ohms at 25 C) were coated (beads and leads) with a silicone rubber sealer to electrically isolate them from the water. The technique was only partially successful, several sensors failed, especially at greater depth, and replacements were required during the measurement program. Due to failures, and other difficulties, some gaps exist in the temperature data for some of the sensor locations. Thermistors were suspended from floats near the "North", "East", and "West" shores at heights, in the water, of 15, 45, and 90 cm above pond bottom. In addition, another chain of thermistors was suspended from a raft near pond center at water depths of 30, 60, and 120 cm below the pond surface. A small float, loosely attached to the raft, supported two more bead thermistors at depths of approximately 3 and 6 cm below the surface. Of these 14 sensors, 8 were chosen (on the basis of reliability) to be averaged as an indicator of slowly changing bulk pond temperature. The locations are specified with the data which appear at the end of this report.

The pond surface elevation was monitored at intervals of two to six hours by direct reading of a meter stick firmly attached to pond bottom. The elevation decreased continuously due to both seepage and evaporation. The seepage was found to be an order of magnitude larger than the evaporation. Evaporation was determined from a standard evaporation pan mounted in the pond water to maintain its temperature at approximately the pond temperature. Seepage was determined by subtracting the small evaporation from the large total water loss. Seepage was not determined independently, it further is not useful to consider subtraction of large seepage from large total water loss to obtain small evaporation. Evaporation pan temperature was read with an National Bureau of Standards traceable mercury-in-glass thermometer at the times of evaporation measurements. Calming wells were not required, however possible future measurements should be based on several depth gauges in the pond and in the pans because of surface tilt at times of persistent winds.

The thermal performance of the pond may be determined solely from the heat loss as evidenced by the decreasing pond bulk temperature (the thermal mode is small-scale convection resulting in a well-mixed pond at all times, the data volume shows very small standard deviation for the temperatures derived from 8 thermistors). Heat is lost in several ways, sensible heat exchange to the atmosphere, evaporation of water to the atmosphere, radiation to the atmosphere and beyond, and conduction of sensible heat and seepage to the earthen walls and bottom of the pond. The latter processes involving the earth are not considered to play a role of consequence in the thermal budget. Seepage represents a loss of water but for water at the pond bulk temperature thereby not affecting the pond bulk temperature. Conduction of heat to the earth below is much smaller than conduction and convection and radiation

of heat to the air above. It is for all of these reasons that effort was expended to make the evaporation pan measurements representative at the possible expense of other less important measurements. Observation showed no sloshing of pond water into the evaporation pan during measurement periods.

6.2 In-Air Sensors and Systems

Dry and wetbulb thermistors (YSI 44006 and YSI 44106) were mounted at the 75, 150, and 300 cm levels above base on towers located near the "North", "East", and "West" shores and on the raft near pond center. The sensors were continuously aspirated within the radiation shields described previously, [2]. The data records from these sensors are complete except for the two lowest levels on the raft for which cabling failures and crosstalk caused unreliable records through the measurement periods. Two more thermistors were mounted on the raft-attached float at heights of approximately 3 and 6 cm above the water surface. These sensors were not radiation shielded nor aspirated. The intended shielding was not used as it became obvious that it interfered with mounting stability in the presence of wind. Data from these two thermistors are less reliable during daylight hours, then, than during nighttime.

Wind speed/direction sensor/transmitters (Climet 011-2B and 012-2C) were mounted at the 1.5 m level on the raft tower at the termini of a 1.5 meter boom/arm. The separated sensors were oriented to experience minimum interference from the tower wake for the expected persistent wind directions. Because of difficulty with specific channels in the digital data recording system, the two outputs were strip-chart recorded. The raft was controlled by ropes to shore for maintenance of desired raft and, therefore, wind direction sensor orientation.

Net radiation over the water surface was monitored continuously by a net radiometer (Micromet, Inc., No. 686, Fritschen) raft-mounted at approximately 0.5 m above the water

surface. The protective hemispheres were purged with dry nitrogen contained on the raft.

The perimeter towers were equipped with 3-component anemometers (Science Associates No. 454, Gill) at nominally the 1.5 meter level above tower base. These instruments are designed for sensitive response to variable wind, they were deployed around the thermal pond, however, to provide data of average wind speed and direction; their proximity to the ground precludes the data from usefully being used for purposes other than averaging.

A second standard evaporation pan was located onshore near the "East" side of the pond. This pan was not heated and therefore the evaporation data is less representative of the pond than that of the immersed pan. Three wedge-type rain gauges were located about the pond periphery, on the "North", "South", and "West" sides of the pond.

An existing 16-meter tower, located at the EG&G environmental building, was instrumented with three levels of aspirated dry and wetbulb thermistors as well as with two levels of 3-component anemometers. This remote tower (150 meters from the pond) was intended to provide undisturbed reference data for comparison with near-pond data. The instrumentation and sensors on the tower were chosen to be identical to that of the pond periphery towers.

A monostatic acoustic sounder (NOAA Mark VII) was located on a slight rise to the Southwest of the pond at about 70 m distance. This location provided separation from potential acoustic reflectors (power poles). The sounder produced information concerning atmospheric stability to a height above ground of approximately 340 m. The continuously-acquired qualitative data are not presented in this report except by reference.

Tethered-balloon (Metrodata Systems) observations were intended in the space over the pond to altitudes of 200 m above the surface. Due to a combination of factors including wind destruction of part of the system, these measurements were not made routinely.

In addition to the net radiation measurements directly over the pond surface, occasional observations were made of the interface temperature with handheld infrared radiation thermometers (Barnes PRT-5 and InstaTherm). These shorebased observations of the pond surface and the surface of the evaporation pans led to some understanding of the difference between the bulk temperature and the skin temperature for these water bodies as a function of temperature and other quantities.

EG&G personnel have provided a continuous record of direct and diffuse sky radiation which enables calculation of total downward radiation (global) for the area intercepted by the pond surface. The instrument (Eppley pyranometer) was located at the Well No. 1 site approximately 1200 m from the pond.

6.3 Sensor Interfaces and Data Recording

All thermistors were contained in simple DC bridge circuits powered by stable mercury batteries and bridge components were chosen to provide a useful range of voltages to the data loggers and magnetic tape recorders. No attempt was made to linearize the bridge outputs except insofar as that which goes along with maximizing bridge sensitivity. The magnetic tape data are computer-handled and it is preferable to do the linearizing there rather than run the risk of introducing unknowns in the acquisition process itself. The anemometer outputs were conditioned by 1:1 stable DC amplifiers to adjust for minor variations from generator to generator. The net radiometer output was amplified and presented as a voltage useful to the data logger.

All thermistors and anemometers (with the exception of the raft anemometer and wind direction sensor) and the net radio-meter provided voltages to digital data loggers (Metrodata Systems and Esterline Angus) and thence to digital magnetic tape recorders (Kennedy and Digidata). All pond and periphery sensors were tape recorded so that all were acquired at 1.96 S intervals. The raft wind sensors were recorded on strip-charts (Fisher).

6.4 System Accuracy

All thermistors to be water-deployed were calibrated, in bridges, in a laboratory procedure prior to field use. Of the array available, thermistors which did not agree with expectation to within 0.1 C were set aside and not used. The calibration was done in a precision temperature-controlled water bath maintained at $50.5\text{ C} \pm 0.01\text{ C}$ and also at $29.6\text{ C} \pm 0.01\text{ C}$ monitored by a traceable thermometer (Brooklyn). The dry and wetbulb thermistors were calibrated in their aspirated shields in laboratory air, all were found to agree with expectation (wetbulb in dry condition) within 0.3 C, most of the departures from expectation are attributable to variability in the actual laboratory air temperature and the attendant difficulty in sensor assessment. The wetbulb thermistors were then wetted and compared with a precision aspirated thermistor psychrometer (Atkins), all were found to agree with expectation within 0.4 C. For the inwater thermistors which survived the field deployment, similar results were found in a post-experiment calibration. All of the dry and wetbulb thermistors were determined to exhibit the same calibration characteristics after the measurement program as they did initially.

Anemometers were provided with new bearings prior to field deployment and were checked for voltage output when driven by a synchronous motor. The minor variations in generator output were compensated by signal conditioning

amplifiers. Wind directions were established with use of a surveyor's transit.

The net radiometer was a new purchase and the manufacturer's data was used as the calibration for this device. The acoustic sounder data is not appropriately described as having an accuracy in result of its qualitative character.

The data loggers and the magnetic tape and strip-chart recorders were checked for recorded values against known voltage inputs, simulating the sensors. The indicated values were made, through system tweaking, to agree exactly with the applied values to within the resolution available in the systems.

6.5 Data Representativeness

All temperature data derived from thermistor sensors are representative of the temperatures the beads experience. In the water, the indicated temperatures are exactly representative of the water temperatures, the slow variation of water temperature precludes nonrepresentativeness due to a finite sensor response to temperature change. The drybulb thermistors have a time constant of approximately 1 s in air moving at aspiration speed greater than 1 ms^{-1} (experimentally determined). The wetbulb thermistors have a time constant of order seconds due to the presence of the wet wick. Because of the requirement for averaging of data, these time constants do not affect data representativeness.

Dry and wetbulb thermistors located on the pond periphery towers provide representative data of temperatures at their locations which reflect the influence of the pond on air temperature and moisture. The remote tower was intended to provide reference data for comparison. The remote tower data are probably fairly representative of undisturbed conditions during daylight hours. During nighttime hours, the remote tower sensors experience the pond influence and, thereby, reference

data is lost. It is a matter of coincidence that the remote tower is located downwind (persistently) from the pond during the nighttime hours. Future measurement programs should include a remote reference tower which is at a sufficient distance from the pond to be truly removed from thermal and moisture influence.

The four thermistors near the water-air interface may experience influences which affect representativeness. The water thermistors, in relatively high wind conditions, may leave the water temporarily for short periods of time, probably much less in duration than the (coated) sensor time constant. The air thermistors, under similar conditions, may enter the water and be warmed and then be cooled on return to the air in result of being wet and acting like a wetbulb sensor. Further, the air thermistors experience direct solar radiation and infrared radiation from the pond surface and may even react to the condensation and reevaporation of water on bead surfaces at times. Data averaging helps to mitigate the combined effect of these influences. Reference to the data for these two thermistors, however, should be made with extreme caution.

Data derived from the anemometers are not representative of rapid fluctuations in wind speed and wind direction because of, primarily, exposure very near the surface below. The half-hour averages presented in the data volume, are however, representative of wind speed/direction for those intervals.

The net radiometer may experience condensation of water vapor on the protective hemispheres especially during nighttime hours. There is nothing evident in the net radiation data, however, that indicates that the data are nonrepresentative for this reason.

Evaporation from the pond was determined from an evaporation pan immersed in the pond. There are reasons to believe

that the pan data is not exactly representative of the pond evaporation. The immersed pan is intended to simulate an undisturbed circular area of the pond with approximately 1.5 m diameter. Departures from similarity include the requisite pan lip which prevents exchange of liquid water between pan and pond, this has an effect of modifying the wind regime immediately over the pan water surface. In addition, because the pan is not totally immersed, the pan water temperature is not exactly the same as the pond temperature. This is true for both the bulk temperature in each case as well as the skin temperature. The pan water exists at a temperature 4 to 10 C less than the pond temperature. Both of these departures from similarity should affect the pan data so as to indicate evaporation less than the true pond evaporation. On the other hand, the immersed pan evaporation should be more representative of pond evaporation than that from the onshore pan. Temperature for the onshore pan ranges from 15 to 40 C less than that for the pond, the extreme variability is due to the influence of the diurnal cycle on the pan water.

Total evaporation over a 72-hour period for the immersed pan with water at temperature near the pond temperature was found to be approximately 2.7 cm and for a 48-hour period 4.0 cm (very different meteorological influences). The corresponding evaporation from the onshore pan was approximately 1.2 and 1.6 cm. Clearly, the immersed pan indicates larger evaporation than does the onshore pan (as expected). The data are not sufficiently complete to enable further analysis.

Evaporation pans have been found to indicate larger evaporation than that from adjacent large water areas [4]. It is believed that this observation results from the substantial thermal inertia of the large water body, the relative lack of response to diurnal heating by comparison to pan response. The evaporation in either case is a strong direct function of

water temperature. For consideration with respect to a hot pond, at temperature always greater than that of pan water, it should be the case, however, that the pan evaporation is less than that of the pond.

The evaporation data available from the measurement periods should be used with caution as representative of the pond evaporation. Pond evaporation should be considered to be at least as large as that from the immersed ("West") pan. The concept of a pan coefficient, and available data pertaining thereto, is not relevant here because of the extraordinary condition of a hot pond to consider. The pan coefficient, as used in the literature, is evidently a stronger function of water temperature departure than it is of pan geometry or structure.

In the event of future measurements on bodies of warm or hot water, careful attention should be given to making pan temperature very close to pond temperature. This can be accomplished by heating the pan water with heater control circuitry referencing the pond temperature, providing a jacket for the onshore pan and circulating pond water through it, or a combination thereof.

In addition, effort should be made to produce data which can provide the opportunity to calculate evaporation from the pond surface by bulk, gradient, or eddy flux techniques. The potential for these calculations having validity is severely limited by instrumentation capability and the fetch-limited situation for the relatively small pond, the complex physical situation is difficult to assess, [5].

For the Raft River pond, in its present condition - that of seepage exceeding evaporation by almost an order of magnitude, there is no justification in attempting to determine seepage independently in order to calculate evaporation through

subtraction of seepage from total water loss. There exists no technique of determining seepage which would even approach the required accuracy to enable the subtraction of two large experimentally-determined quantities to obtain a useful residual. Further measurements must be accomplished for a pond which does not seep, the monitoring of pond surface elevation provides, then, a desired back-up measurement of evaporation.

7. MEASUREMENT SCHEDULE AND DATA AVAILABILITY

Battelle personnel arrived at the Raft River site on April 18, 1977 and had installed the measurement systems and determined bottom topography by April 21. On that date the site was inspected by a representative of the Nuclear Regulatory Commission. At the time of the visit it had been determined that the main digital logging and recording system and/or local electronic noise and grounding errors were preventing the recording of valid data. Correction of system problems was accomplished, with the onsite assistance of a factory engineer, to the extent that pond filling was initiated on the morning of April 26 with reasonable expectation of the acquisition of a useful data set. Even though the intent had been to initiate data collection at an earlier time (based on satisfactory system performance in the laboratory), the first measurement period was actually initiated at 1000 hours (MST) on April 27. The duration of monitoring for this period was 48 hours, terminating at 1000 hours on April 29. A second measurement period was initiated at 1000 hours on May 1, terminating at 1000 hours on May 4 for a duration of 72 hours.

The measurements for both periods consisted of monitoring, with all active systems, the pond and its environment as the pond cooled from an initially high temperature (approaching 50 C) to approximately 27 C. During the measurement episodes, no water was added nor drained from the pond and, with the unimportant exception of seepage, the only influences on the pond thermal performance were those of the ambient meteorology.

No unusual meteorological events occurred during the first measurement period, during the second period there were periods of rain (of measurable amount) which affected evaporation rate significantly as evidenced in the evaporation pan data.

The data volume contains half-hour averages of the data obtained during these two measurement periods. Gaps in the data listings are attributable to sensor and system failures of temporary duration. A total absence of data from sensors described previously is an assertion that the corresponding electronics channel did not respond to any technique of repair.

8. DATA DESCRIPTION AND SAMPLE CALCULATIONS

Accuracy and representativeness of the data are discussed in Chapter 6 of this report. The data from various sensor systems are of high quality and of large quantity. Most of the data were obtained so that each sensor output was recorded each 1.96 s over periods of 48 and 72 hours. It is not possible, nor appropriate, to contain all of this in this report. The entries in the data volume are half-hour averages for the various quantities and for other quantities derived therefrom; data volume entries are for the preceeding half-hour in every case. The relatively high speed of data acquisition was chosen so to enable some calculations of short-term periodicities for dry and wetbulb temperatures. The remainder of the data were acquired with a slower digital system (each 10 seconds for the reference tower) and manually at intervals of 2 to 6 hours (pond and pan levels). The reference tower data are incorporated in the data volume and the manual data are presented graphically. The higher speed (1.96 s) data are available for study as required.

8.1 General Data Interpretation

Temperatures were obtained in the pond, as the pond cooled from an initially high temperature, with thermistor sensors located as described in Chapter 6. Of these, the eight thermistors - "East" chain, top, middle and bottom, Raft chain, top middle, and bottom, "West" chain top, and Float top - were averaged to produce the pond bulk temperature. This slowly varying quantity is utilized to calculate the loss of heat by the pond to the surroundings. The average is appropriate to use in the calculation as it was found that the pond exists, throughout the cooling periods, in a state of convective overturning and mixing on a small space-scale - the standard deviation for the half-hour temperature averages is comparable in magnitude to the accuracy of the sensor temperature indications.

Both the bulk temperature and the standard deviation are listed in the data volume. Graphical display of the bulk temperature vs. time is presented in several of the figures in this chapter.

Surface elevation was monitored for the pond water and for the water in two evaporation pans, one maintained near the pond temperature and the other onshore and allowed to respond to meteorological influence without direct pond influence. These data were obtained by reading of meter sticks at intervals of convenience, usually the readings were separated by 2 hours, at times the intervals between readings were as long as six hours. Graphical display of these data is presented in this chapter.

Surface elevation was monitored for the pond water and for the water in two evaporation pans, one maintained near the pond temperature and the other onshore and allowed to respond to meteorological influence without direct pond influence. These data were obtained by reading of meter sticks at intervals of convenience, usually the readings were separated by 2 hours, at times the intervals between readings were as long as six hours. Graphical display of these data is presented in this chapter.

Dry and wetbulb temperatures were obtained continuously at 1.96 s intervals at three levels on each of three short towers at a pond periphery and on a similar short tower mounted on a raft at pond center. These temperature data illustrate the condition of the air near and over the pond in response to the pond's thermal and moisture influence. Examination of the data volume shows correspondence between wind direction and an a priori suggestion of which tower(s) should show these influences. Reference tower temperature data are not representative because they were affected by pond influence, especially at nighttime when the wind was coincidentally and persistently blowing in

the direction of the tower from the pond. Further, it appears that the indicated diurnal oscillation in the reference tower temperatures is not as large as should be expected; a reason for this is the effect of a nearby, heated instrumentation building. All of these data are listed in the data volume and some periphery tower data is also presented in graphical form.

Wind speeds and directions were obtained from 3-component propeller anemometers on the periphery towers and at two levels on the reference tower. These data are accurate and representative for half-hour averages of the 1.96 s interval recorded data. Speed in the horizontal and the horizontal direction were computed from the two horizontal component data at each 1.96 s interval and then these were averaged. The rectangular pond is tilted at 45 ± 1 with respect to the cardinal compass directions. A wind direction of 225 degrees, as listed in the data volume, corresponds, then, to the "South" to "North" direction with respect to pond labeling. All of these data, including vertical wind speed (positive value is an updraft), are listed in the data volume. Wind speed and direction were also obtained from the raft; the sensors were separate cupwheel and vane and the recording was on strip-chart. The stripchart records were read for representative half-hour values and the data are presented as a graphical display in this Chapter.

Global radiation - direct solar and diffuse at all wavelengths was continuously strip-chart recorded by EG&G personnel during the measurement periods. These data were used in a calculation to determine the total radiation intercepted by the pond area. Only a portion of the total energy/time acts as a thermal load on the pond, a significant fraction is reflected from the pond surface. Net radiation was determined continuously, at 1.96 s intervals, from a net radiometer mounted on a boom from the raft and overlooking the pond water. These averaged data give indication of the difference between incoming

radiation (a fraction of which is actual thermal load) and outgoing thermal and reflected radiation from the water surface. The difference can be either positive or negative, a negative value here is for outgoing in excess of incoming radiation, the condition most often experienced at night when the sun is below the horizon. Both the total down and net radiation are substantially affected by the state of the sky in terms of cloudiness. The data volume contains both sets of data and also, in this Chapter, are graphical displays of the data.

Water surface skin temperatures were determined on occasion with hand-held infrared radiation thermometers. It was found that the skin temperature ranged from 1.5 to 4.5 C below the bulk temperature for the pond under various conditions of sky radiation, wind speed, air temperature and moisture, and time-of-day (sun position). The same maximum difference was obtained for water in the two evaporation pans but the minimum difference became as small as 1 C. For the data obtained, no evident relationship between bulk temperature and skin temperature could be established. The data are too few to analyze for functional relationships with the various meteorological influences.

The acoustic sounding system provided a qualitative display of changing conditions of stability in the atmosphere to a height of 340 m above ground level. The expected nocturnal layering (thermally) was evidenced with erosion of stability following during the early morning hours. Thermal convection, initiated near or at ground level was observed during daytime hours with layering becoming established during the early evening. In no way is it evident that small-scale (10's of meters) convection from the pond becomes suppressed by the stable layering above. The facsimile-type records are not appropriate for entry in this report.

8.2 Data Volume Interpretation

Entries in the data volume are listings of half-hour averages for the various measured and calculated quantities. Two successive sections list data for, firstly, a continuous 72-hour period of acquisition and, secondly, a 48-hour period of acquisition. The half-hour averages are computed for the half-hour preceeding the time listed in the first column of the data volume.

The second column lists, in Celsius degrees, the mean bulk pond temperature calculated from 8 thermistors at various locations in the pond water. It is from this changing quantity that heat loss by the pond is calculated (with consideration of changing pond volume, primarily due to seepage). Following the listings of pond bulk temperature are the corresponding standard deviations, in Celsius degrees, calculated from the 8 thermistor temperatures for each half-hour interval. These values of standard deviation are small and are comparable in magnitude to the accuracy of the thermistor indications of temperature. For this reason, it may be stated that the pond did not exist in a stratified mode, that mixing was sufficient, at all times, to produce essentially thermal uniformity.

The next two columns are measures of radiation. First is listed the total downward radiation intercepted by the pond area, a fraction of which represents a thermal load on the pond water. The following column lists the net radiation measured near the pond surface. Both of these quantities have been calculated to represent a magnitude for the entire pond surface and are expressed in megawatts. The small change in pond surface area (maximum of 5%) has not been incorporated into these results.

The next four columns list data for the remaining quantities measured by raft-mounted instrumentation. Wind speed is listed in meters per second and wind direction in degrees with "zero" (360) representing true North, values are entered per the usual

meteorological convention. Drybulb and wetbulb temperatures are in Celsius degrees and are entered for the top level of raft instrumentation. The two entries below the drybulb entry are for the two float air (drybulb) temperatures near the water surface. The topmost value is the temperature nearest the water surface. Described earlier (Chapter 6) are reasons to approach the use of these quantities with caution.

The next three groups of four columns each are listings of the data for the "East", "North", and "West" periphery towers. The first line of each group is the same as for the raft format. In each case, however, the vertical wind speed, in meters per second, has been entered below the horizontal wind speed, a positive value is an updraft. Also listed are three levels of drybulb and wetbulb temperature in ascending order of height above ground, the first entry pair being the lowest level.

The final group of four columns lists the data for the reference tower. This group is identical in format to that for any of the peripheral towers except that a second level of wind information has been added (the level highest above ground). The lower reference tower wind (and temperature) level corresponds, in height above ground, to the upper level on the peripheral towers.

8.3 Sample Calculations and Graphical Data

The bulk of the data are presented as half-hour averages in the data volume; those data that were obtained manually, i.e., pond surface elevation, evaporation pan depths, and evaporation pan temperatures, are presented graphically in this Chapter. The graphical displays, including some for the data volume, are useful for a view of changing quantities during the 72-hour period of data acquisition. Some sample calculations are also included to further illustrate the processes of interest.

8.3.1 Pond and Pan Water Loss

Loss of water by the unsealed pond to the sand and gravel composing the bottom and sides is approximately an order of magnitude larger than the loss by evaporation to the atmosphere above. Figure 8.1 indicates the relative changes, the depth scale is arbitrary and any procedures of pan filling have been taken into account in the graphs displayed. Rain episodes are reflected in the pond and pan data, especially for the rain on May 4; the earlier episodes do not show such obvious effect on the depth data. The warm pan, placed in the pond water, and the pond itself do not appear to strongly indicate the fact of rain probably because the rate of evaporation on May 1 is relatively large. The ambient (onshore) pan, with a very much smaller evaporation rate, because of substantially lower temperature, indeed indicates depth increase because of rain. The indicated large evaporation rate between 0800 and 1000 hours on May 2 may be in result of a reading errors at those times, there is no cumulative error involved.

The short arrows, pointing upward from the horizontal axis of the graph, indicate times at which the pond bulk temperature is found to not change (not decrease) for periods of a half-hour or more (the shorter arrows); the longer arrows indicate those times for which the pond bulk temperature is found to actually increase on the order of 0.1 C on the same time-scale. These arrows are seen to correspond in time with episodes of reduced evaporation from both pans and will be discussed further with respect to other influencing quantities.

Evaporation as determined from the warm evaporation pan is conservative in magnitude if considered representative of the pond evaporation. The primary reason for this is that the warm pan exists at a temperature lower than the pond temperature. This is illustrated in Figure 8.2 in which the temperature difference is seen to be as large as 12 C. Evidently, it is

Figure 8.1 Surface elevation change for the pond and two evaporation pans. The depth scale is arbitrarily numbered, relative heights, however, for a given water body, are obtained by subtracting the data expressed in centimeters. The shaded areas represent rain duration and the arrows are described in the text.

Figure 8.2 Variation in temperatures for the pond and the two evaporation pans. The pond temperature is a bulk temperature obtained through averaging 8 thermistor indications.

necessary to take measures to decrease this difference for further measurement episodes. The pond evaporation must be considered at least as large as warm pan evaporation and here is taken to be the same.

The ambient pan is responsive, by comparison, to the diurnal cycle of meteorological influence. Evaporation from the ambient pan is even less representative of the pond evaporation. The vertical segments in both pan curves indicate pan relocation in the falling pond or addition of water to top the pan off. The arrows, again representing times at which the pond experiences no bulk temperature decrease or an actual increase, correspond in time with maximum pan temperature. This is not consistent, physically, with the previous observation that the arrows corresponded in time with smaller pond cooling. However, other influences must yet be considered.

Considering only the influence of water temperature, it may be stated that evaporation is related to vapor pressure. The vapor pressure, in the range 10 C to 40 C, is closely a direct function of Celsius temperature only, the pressure increases somewhat more rapidly than does temperature in this range. The other major influence of importance, however, on the pond (and pan) temperatures is the radiative load from the sky. It is because of this influence that the pond exhibits minimum cooling at times of maximum pan evaporation.

The data do not show an evident effect of precipitation on either pond or pan temperature. If such an effect exists, which is doubtful considering the relative quantities of water involved, the result is further masked by other influences. Inspection of the curves of Figure 8.2 may indicate some change of slope in the water loss curves, in association with precipitation, but the proper relationship is to the conditions attendant with the rain - cloudy skies, thereby affecting the radiative exchange, and wind and ambient drybulb-wetbulb difference.

8.3.2 Radiative Influence

The pond experiences a heat load during daytime hours in result of direct solar radiation as well as diffuse sky radiation intercepting the pond surface area. A fraction of this energy represents the actual load on the pond, a portion is reflected from the pond surface and this portion is very dependent on the height of the sun in the sky, the amount of diffuse radiation by comparison with direct radiation - this is further dependent on the extent of cloudiness, and the state of the water surface. Waves are produced by wind action and the actual thermal load is greatly affected by reflection conditions in the presence of waves (primarily the capillary waves). Nonetheless, it is important to know the times of day during which the radiative influence on the pond is maximum. Figure 8.3 illustrates this with total downward radiative energy plotted vs. time as calculated for the whole pond area, the units are megawatts. The pond bulk temperature also appears in this diagram, plotted on a temperature scale which is expanded from that of Figure 8.2. It is seen that there exists one-to-one close correspondence between times of maximum radiative influence and minimum pond cooling. It is apparent that this influence on bulk pond temperature overwhelms the evaporative influence. Large radiative loading of the pond exists, however, for only relatively short periods of time.

Data are also plotted for net radiation measured over the pond surface near pond center. Areas between this curve and the zero-ordinate are lightly shaded in the figure. The values are negative during nighttime hours and this is a statement that the pond is losing energy during those hours by radiative exchange to the sky, and, primarily, water vapor above. An integration of the net radiation over the 72-hour period shows a mean 0.03 (negative) megawatt loss of heat by the pond. Actually the mean loss of heat by the pond is larger than this because the

Figure 8.3 Radiative energy rates expressed in megawatts and computed for an area equal to the pond area. These are plotted against a background of the falling bulk pond temperature. Shading is associated with net radiation, the highest peaks are those of total downward radiation.

downward component, during daylight hours, is not totally involved in pond loading due to reflection.

8.3.3 Wind and Temperature Influence

Evaporation from the pond, and thereby pond cooling, and the direct transfer of heat to the atmosphere by conduction, should both be influenced by wind and by wetbulb depression as well as by difference in pond temperature and ambient air temperature. Figure 8.4 again shows the changing pond bulk temperature as well as half-hour averages of wind speed as obtained from the raft near pond center. Short-term variations in pond bulk temperature can be associated with extremes in the wind speed pattern. Times of maximum pond cooling rate are seen to coincide with peaks in wind speed, this is especially apparent during the beginning hours of the 72-hour period when the pond is at its most elevated temperature. Minimal pond cooling seems to be less evidently related to minima in the wind speed, again the radiative influence masks the wind influence at these times (periods of relatively high wind speed coincide in time with periods of maximum downward radiation).

Drybulb and wetbulb temperatures are plotted in Figure 8.4 for the uppermost level of the "East" tower. These plotted values are influenced by pond proximity and the magnitude of this influence is related to mean wind direction. Peaks for both temperatures are seen to coincide with peaks in the wind speed and, by reference to Figure 8.3, with peaks of downward radiation. At least some of the influence of ambient temperature (dry and wet) on pond response will be either masked by radiative effects and wind effects or has, in effect, already been taken into account implicitly. Peaks in the drybulb temperature are in synchronization with minima in the pond bulk temperature cooling rate. Maxima of wetbulb depression are in phase with these even though the separate effects are in opposite sense. The sorting-out of these various influences requires further data acquisition.

Figure 8.4 Wind speed and drybulb and wetbulb temperature plotted against a background of falling pond bulk temperature. Representativeness of the temperatures is discussed in the text.

Some detail concerning nonrepresentativeness of the remote tower temperature data is presented in Figure 8.5. Here the "North" tower upper level drybulb temperature and the remote tower lower level drybulb temperature are compared (these two levels are the same height above ground). The data are presented for a 24-hour period near the center of the 72-hour measurements. During daytime hours, it is believed that the remote tower gives fairly representative undisturbed indication of temperature, the excess temperature for the near-pond tower is in result of proximate pond influence. Wetbulb temperatures are also plotted for short segments of time corresponding to the maximum and minimum in the drybulb temperatures. These data have been used to calculate absolute humidity near the pond and away from the pond. The absolute humidity is larger near the pond as would be anticipated. For these daylight hours the wind tends to blow from the remote tower to the pond.

During nighttime hours the wind persistently blows from the pond to the remote tower. This accounts partially for indicated drybulb temperature being higher at the remote tower during these hours. However, this reason cannot account for the total apparent discrepancy. It is believed that the presence of an instrumentation building, at remote tower base, has further affected the remote tower temperature data. The building was kept at an elevated temperature, interior temperature was at least 20 C above exterior ambient temperature during the nighttime hours. Further, the building is of sheet metal construction and, unfortunately is located on the pond side of the remote tower. The data, when used in calculations of absolute humidity to compare with that at the pond do not give encouraging results - the remote tower cannot be considered as providing truly representative reference data.

Figure 8.5 Drybulb temperature plotted for 24 hours, reference tower and "North" tower data from the 3 m level. Short segments of wetbulb data are also shown. The representativeness of these data are discussed in the text.

8.3.4 Thermal Structure Over the Pond

Temperature and moisture of the air above the pond become elevated in result of transport of heat and water vapor from the large warm reservoir below. Processes of conduction, convection, radiation, and evaporation all play a role. The thermal performance of the pond may be calculated from the changing bulk temperature and the changing pond volume alone. For extrapolation of the results to other ponds of different size and configuration, however, information is required to describe the processes themselves.

One item of significance in potential modeling of cooling ponds is the establishment of convective activity over the pond surface. Especially for light wind conditions, the efficiency of heat and water vapor transport from pond to air is affected. Data are plotted in Figure 8.6 for an approximately 150 s period during the wind minimum at midnight May 1 - May 2. The ordinate of the figure is raw voltage from the magnetic tape record, temperature increases essentially linearly toward the bottom of the page. An indication of the magnitude of variations in drybulb and wetbulb temperature is given. The onshore "East" tower data are compared with the raft data for essentially the same elevation above the surface - 3 m. The onshore tower displays data with very modest variation; the variations in wetbulb temperature are less than those for drybulb temperature, this is expected in result of the longer time-constant for the wet-wicked thermistor. On the raft, however, the variations on short-term are very much larger, of the order of Celsius degrees. Again, wetbulb variations are smaller as expected concerning the difference in sensors; it is possible that some of the difference might be attributable to a real difference in the structure of temperature and moisture convection from the pond surface. The character of the data displayed in the 150 s time-segment is representative of that for longer periods of time, up to hours in duration for extremely light wind conditions.

Figure 8.6 A comparison of wetbulb and drybulb data over and near the pond for light wind conditions. The vertical scale is indicated by the double-ended arrow at lower left. Temperature increases toward the bottom of the page.

Examination of the longer records, and Figure 8.6, indicates a periodicity in the temperature data. Mere inspection suggests that this period is of the order of one minute.

The data (1.96 s intervals) for an approximate half-hour period were analyzed for periodic contributions to this apparent periodicity through application of a Fast Fourier Transform technique. This technique enables the identification of spectral amplitudes and the results are displayed in Figures 8.7 and 8.8. These results will not be overly interpreted because of the various philosophical and technical assumptions required in its application to time-series data. The data were at least partially detrended prior to analysis.

Period in seconds comprises the horizontal axis of the figures and spectral amplitude in millivolts, with indication of the corresponding temperature scale, is indicated in the vertical. The onshore data do not display much of interest beyond, as expected, larger amplitudes for the drybulb data throughout the spectrum. The raw data suggest a "noise" contribution of period between 6 and 8 s, there is some evidence of this in the spectral data. These indications are interpreted as some evidence of the validity of the statistical technique in this application. The large amplitude at the long-period end of the spectrum probably represents residual trend in the data to which the FFT is applied. Small amplitude enhancement is seen at periods of 13, 17, and 85 seconds.

The raw data require that the amplitude spectra be, by comparison, more spectacular over the pond surface. Figure 8.8 indeed indicates this, the amplitudes are larger overall and there exists a well-defined amplitude enhancement between 36 and 85 seconds. Both drybulb and wetbulb variations have a substantial contribution (periodic) at about one minute intervals.

Figure 8.7 Spectral amplitudes for time-series temperature data (near-pond tower). The data of Figure 8.6 are representative of that used in the FFT procedure. The amplitude scale is indicated just to the right of the page center.

Figure 8.8 Spectral amplitudes for time-series temperature data (raft tower). The data of Figure 8.6 are representative of that used in the FFT procedure. The amplitude scale is indicated just to the right of the page center.

These results may be interpreted as evidence of periodicity in the way warm, moist air leaves the pond surface for very low wind conditions. Similar analyses for the case of appreciable wind indicate no such amplitude enhancement, the spectral amplitudes are very much smaller as would be expected, and the "noise" amplitude becomes, relatively, very much larger as would also be expected.

It is envisioned that a layer of air near the pond surface becomes heated through absorption of thermal radiation by enhanced water vapor content and by convection from the surface on a small space-scale (on the order of cm or 10's of cm). Some direct conduction of heat also occurs. After a time, conditions become critical for overturning convection on a larger space-scale (on the order of meters) and there is a rising of warm, moist air from near the pond surface and past the raft sensors at an altitude above surface of 3 m. This condition might be quantitatively described by a critical Rayleigh number specific to a layer of air influenced by a lower heated rigid boundary with a free boundary at the top.

Once this bodily transport has occurred, conditions are ripe for the formation of another warm, moist layer near the water surface and the process repeats as long as the conditions do not change significantly. As a layer convectively rises, other air must flow in to take its place over the pond. It is believed that Figure 8.7 indicates this, the modest amplitude enhancement at 85 s period could represent the response by the ambient air near the ground.

This process is likely less efficient as a heat transfer mechanism than that which will occur when the wind is blowing. For appreciable wind, there is always a ready supply of relatively cool, dry air to enable enhancement of transfer by evaporation and conduction. Loss of heat by the pond due to radiative exchange probably would be enhanced also, there would

be less back radiation in the situation of less water vapor directly above the pond (it has been blown away).

For the case of low wind conditions, especially, it becomes useful to know what transpires for the rising air after it leaves the immediate vicinity of the pond surface, say above the 3 m level. It has been found that the acoustic sounding data, while useful in considering stability (or lack thereof) in the surrounding atmosphere, does not indicate pond influence for primarily two reasons. Firstly, the first 30 m of the atmosphere are not assessed because of electronic gating requirements in the system. It is anticipated that probably the first, say, 30 m are the most interesting with respect to convective structure, entrainment and probable appreciable wind above this height will soon destroy any convective plume or thermal. Secondly, the techniques are not conveniently available to assess the air directly in the vertical above pond center.

A technique which is available to assess the convective structure directly over the pond center, and to heights of several 10's of meters is by tethered balloon-telemetry sounding. The balloon would be controlled with a three point-winch tether for adequate control of balloon position even in appreciable wind. The required meteorological parameters of wind speed/direction, drybulb and wetbulb temperatures, altitude above surface, and even net radiation may be obtained in time-series format. High winds and consequent destruction and damage to components of the tethered-balloon system prevented the acquisition of data from this system during the measurement periods. It has been determined how to avoid these difficulties in the future.

8.3.5 Heat Loss by the Pond

The pond loses heat to the surroundings by processes of radiation, conduction, evaporation, and convection. The continuing loss, in an approach to an equilibrium temperature, is

influenced by the meteorology which it experiences. Even though seepage represents the major contribution to water loss, it may be considered that seepage does not contribute to the thermal performance since seepage water leaves the pond at the bulk pond temperature (seepage loss has been considered in calculations involving pond volume at any instant of time). Seepage, and the fact that thereby the soils comprising the pond bottom and sides are soaked, will only indirectly affect the thermal performance, and in a small way, by changing the thermal conductivity of the soil. The engineering data show that the ratio of conductivity for water to sand is approximately 1.5. On the one hand, then, seepage may affect thermal performance by slightly increasing heat loss. On the other hand, the wet soil, if this is true, then has the opportunity to transfer heat back to the pond as the pond further cools. These opposing effects should result in a small residual by comparison with the major influences caused by the changing meteorology.

Half-hourly values of total heat loss by the pond are shown in Figure 8.9 for the 72-hour data period. The values are calculated from the changing pond bulk temperature and volume, the segmented appearance of the graph is due to choosing 0.1 C as accuracy resolution in the bulk temperature data. Heat loss is large when pond temperature is high and vice versa. At all times the pond existed at a temperature well above ambient. The zero and negative values correspond to half-hour intervals when the pond did not cool or actually heated slightly in result of the influence of (primarily) downward direct and diffuse radiation. It is seen that the pond, at temperatures between approximately 27 and 40 C, loses heat at a rate between 1 and 2 megawatts. At temperatures above 40 C, the rate is much higher, a characteristic value would be as much as 7 megawatts at 45 C.

Table 8.1 contains quantitative information of various measurements on the pond over the 72-hour period as well as a linear extrapolation to a pond of one acre.

Figure 8.9 Total heat loss by the pond expressed in megawatts. The segmented appearance of the curve is attributable to choosing temperature (pond bulk) to have 0.1 C resolution.

Table 8.1 Various Results of Calculation on 72
Hours of Pond Data. The Values in
Parentheses are Extrapolated from the
Pond Area of 0.8 Acre to 1.0 Acre.

Total change during 72-hour measurement period

- 1) Pond depth - lowered by 34.5 cm
- 2) Pond area - reduced by 178 m^2 from 3277 m^2
initially
- 3) Pond volume - reduced by 1101 m^3 from 4829 m^3
initially
- 4) Warm pan depth - lowered by 3.58 cm
- 5) Pond evaporation - 114 m^3
- 6) Seepage - 987 m^3
- 7) Mean total pond heat loss - 1.44 Mw (1.82)
- 8) Mean evaporative loss - 1.06 Mw (1.34)

9. SUGGESTIONS FOR FUTURE MEASUREMENTS

Models presently being used to evaluate and predict the thermal performance and water usage of ultimate heat sinks have not been validated with data obtained from facilities experiencing a genuinely large heat load. Cooling ponds at elevated temperature are few in number, it is suggested that further data from the Raft River pond is necessary to complement that obtained to date.

The data required include: drybulb and wetbulb temperature, wind speed and direction, direct, diffuse, and net radiation, as measures of meteorological influence. The temperature and wind parameters should be obtained as profiles. Response parameters which are required are those of bulk pond temperature, evaporation, temperature profiles in the soil under and surrounding the pond, and the measurements necessary to quantitatively define structure of the thermal plume above the pond water. Much of this has been determined for the seeping geothermal pond.

The next set of measurements should be accomplished on the same pond but with the pond modified to totally eliminate any potential difficulties with the fact of seepage. This may be accomplished through the lining of the pond bottom and sides with already-tested plastic sheeting. The plastic is designed to withstand the expected high temperatures of the contained water and is sufficiently durable to allow the impacts associated with instrumentation deployment. The pond will be drained so that the plastic can easily be installed and so that proper attention can be given to sealing the overlapping seams of 30 m-wide plastic sheets. At the same time, attention can be given to smoothing the pond bottom configuration and the bottom topography will be determined with great precision. It is expected that, with following pond filling, initial temperatures

approaching 85 to 90 C may be obtained. Monitoring of the pond as it cools to approach the equilibrium temperature would then follow.

Potentially, it is possible to establish, in addition, a current regime in the sealed pond through the introduction of hot (97 C) geothermal water at one location and the simultaneous removal of cooler water at another location. Further information may be thereby derived concerning the thermal performance for various conditions.

Our expectation is that the sealed geothermal pond could be usefully and conveniently converted to a spray pond through the addition of a piping system containing commercially-available spray heads. A program of measurements on the spray facility could be integrated with final measurements on the cooling pond.

It is appropriate to plan for at least two separate measurement programs. The first would be scheduled for late spring to obtain data specifically complementary to that already obtained. The second would be scheduled for a period during the summer in anticipation of meteorological conditions most in alignment with Regulatory Guide, [3], criteria.

For the cooling pond measurements, several questions need to be addressed and some specific attention must be given to measurement techniques:

- Evaporation must be determined in ways which are as representative of pond evaporation as possible. These techniques will include the required controlled heating of an evaporation pan to maintain its temperature within 1 C of the pond temperature at all times. Circulation of pond water through a pan jacket or differential control of pan heaters by sensors in the pond and in the pan are both useful techniques; furthermore, a combination of the two methods might be especially useful. The

sealing of the pond will enable a precision backup (or primary) determination of evaporation. With the acquisition of profile drybulb and wetbulb data from the raft tower, the potential may be available, with additional water temperature information, to, further, calculate the evaporation.

- . Water surface elevations for pans and pond must be determined with precision and at intervals frequent enough to enable determination of evaporation rate as a function of water temperature and all of the varying meteorological quantities. The elevations may be determined, with sufficient precision, through the deployment of sensitive gauges and the use of calming wells as required. For the pond, the use of at least two such gauges is required because of the likelihood of surface tilting in response to persistent wind. Our search for and consideration of recording gauges persuades us of the need to perform manual readings, these should be accomplished at intervals no longer than one hour through 24-hour days.
- . With accurate and frequent reading of sealed pond and pan surface elevations, precipitation, then, will therefore be determined with precision. To complement this information, which has the highest probability of representativeness, a precision rain gauge should also be deployed and it should replace wedge-type gauges in further measurement episodes.
- . State-of-the-sky may be monitored with continuous operation of a time-lapse movie camera equipped with a whole-sky lens. With the additional information provided by maintenance of a weather log, general weather conditions will be adequately monitored.

- . Radiation data must be obtained to enable quantitative estimation of the actual radiative thermal load on the pond. The thermal load is a fraction of the energy contained in the total downward radiation, the fraction is affected in many ways including sun location, sky state, water surface state (waves), water clarity as a function of wavelength, and the absorbing character of the plastic liner. Net radiation is complementary information and we suggest the deployment of more than a single net radiometer.
- . Conductive transfer of heat in the soil comprising pond bottom and sides plays a role in the thermal performance of the pond, the magnitude of this contribution (and, indeed, its sense) must be determined. Temperature sensors will be deployed to provide the requisite temperature gradient information to enable to heat flux calculations. Flux plates may be additionally buried at the appropriate locations.
- . A reference meteorological tower will be sited at a location which experiences the least possible pond thermal and moisture influence. This will be a new facility and will not require reliance on the existing (nonrepresentative) tower.
- . The tethered-balloon telemetry system must be deployed at times of low wind speed conditions to enable determination of thermal plume structure above the pond surface. Data will be obtained to heights of several 10's of meters and probably to as much as 200 meters above pond surface and vertically above pond center. Hopefully, these data may overlap the raft tower data near the water surface. The acoustic sounding system will be located in the downwind direction for light winds. The resulting qualitative data will complement the tethered-

balloon and tower quantitative data in defining thermal structure and establishing stability criteria aloft.

- Temperatures at the water-air interface and near this interface will be determined with accuracy and representativeness - continuously with properly shielded and aspirated thermistors in the air within a few cm of the interface. The interface temperature may be determined at intervals of convenience (for comparison with bulb temperature and for use in calculations of fluxes) with hand-held infrared thermometers. Some attention must be given to the representativeness of such determinations, especially when downward radiation is being reflected from the water surface.
- In the event of the deliberate establishment of currents in the pond water, the currents will be defined through the use of various tracer techniques to include biodegradable dyes for interior flows and simple floats for surface flows. It is expected that the remote technique of infrared sensing of surface temperature will also be useful in this respect. Further, with judicious choice of inwater thermistor locations, the thermal currents may be grossly defined on a continuing basis. It is possible that sensitive propeller-type flowmeters (already tested) may provide complementary information; it is required that flowrates at inlet and outlet be determined.

10. REFERENCES

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APPENDIX A

Data Volume

5/1 1330	43.9	.15	0.6	0.6	4.5	162	10.2	16.1	5.2	154	10.0	16.5	5.3	152	11.4	16.9	4.5	150	13.4	17.3	7.2	156	10.0	11.0
								23.1	-0.1		10.4	16.2	0.3		11.3	16.4	0.4		13.0	16.7	-0.4		9.9	10.9
								20.9			10.9	15.9			9.9	15.8			11.2	16.0	7.8	153	9.6	10.8
																					-0.2			
5/1 1400	43.7	.12	1.0	0.5	4.0	162	10.3	16.5	2.0	156	9.9	17.0	2.3	156	11.7	17.6	1.8	162	12.3	17.4	4.2	170	10.2	11.3
								23.0	-0.1		10.4	16.8	0.2		11.5	17.0	0.1		12.6	17.1	-0.3		10.2	11.2
								22.3			11.1	16.6			10.2	16.7			11.2	16.7	4.8	167	9.8	11.2
																					-0.1			
5/1 1430	43.5	.12	1.1	0.5	2.2	198	10.4	17.5	3.3	189	9.9	17.8	3.7	187	12.6	18.6	3.1	201	11.5	18.1	4.6	198	10.3	11.6
								24.0	0.0		10.4	17.5	0.4		12.0	17.9	0.0		12.3	17.9	-0.1		10.3	11.5
								23.2			11.1	17.2			10.4	17.5			11.0	17.4	5.0	195	9.9	11.5
																					-0.1			
5/1 1500	43.2	.13	1.3	0.8	2.2	216	10.5	18.0	3.4	202	10.5	18.9	3.8	203	13.2	19.4	3.5	205	11.7	19.0	4.8	211	10.5	11.8
								25.3	0.0		10.9	18.5	0.5		12.6	18.6	0.0		12.7	18.7	-0.1		10.5	11.7
								24.4			11.6	18.0			10.9	18.2			11.2	18.1	5.2	208	10.0	11.7
																					-0.1			
5/1 1530	42.8	.17	1.3	0.1	3.6	184	10.3	17.2	5.2	151	10.0	17.4	5.0	147	11.3	17.8	4.2	149	13.1	18.3	6.8	153	10.4	11.6
								23.3	-0.1		10.6	17.2	0.3		11.6	17.4	0.4		13.1	17.8	-0.4		10.4	11.5
								22.6			11.3	17.1			10.1	17.0			11.4	17.2	7.5	149	10.0	11.5
																					-0.2			
5/1 1600	42.2	.21	0.5	-0.1	6.7	162	9.3	12.1	6.7	157	9.1	12.0	7.0	157	10.3	12.6	5.9	157	11.9	13.2	10.0	162	9.2	9.7
								23.1	-0.2		9.4	11.9	0.4		10.0	12.2	0.5		11.2	12.7	-0.6		9.2	9.6
								19.6			9.5	11.9			9.0	11.9			9.9	12.1	11.1	159	9.0	9.7
																					-0.4			
5/1 1630	41.8	.19	0.1	-0.1	2.7	198	9.1	10.9	2.3	169	9.0	10.4	2.8	166	10.5	11.6	1.9	176	11.0	11.6	3.5	176	8.9	9.2
								19.9	0.0		9.1	10.4	0.2		9.9	11.1	0.2		10.6	11.4	-0.2		8.9	9.2
								18.1			9.0	10.5			9.0	10.8			9.6	10.8	3.9	172	8.8	9.2
																					-0.1			
5/1 1700	41.7	.18	0.5	0.2	0.9	234	9.4	11.5	0.8	235	9.6	11.5	0.9	218	10.5	12.2	0.8	233	10.0	11.6	1.1	230	9.1	9.5
								18.1	0.0		9.6	11.4	0.2		10.1	11.8	0.0		10.1	11.6	-0.1		9.1	9.4
								16.9			9.4	11.4			9.4	11.6			9.4	11.2	1.1	228	8.9	9.5
																					-0.1			

5/1 1730	41.5	.18	0.4	0.4	1.3	V	9.8	12.8	1.4	138	9.8	12.9	1.6	131	10.1	13.0	1.2	140	11.2	13.3	1.8	154	9.4	10.0
								20.4	0.0		9.9	12.8	0.1		10.0	12.7	0.2		11.2	13.1	-0.1	9.4	9.9	
								19.2			9.9	12.6			9.2	12.5			10.4	12.8	2.0	152	9.2	
																					0.0			
5/1 1800	41.3	.23	0.2	0.1	0.9	V	9.6	12.9	0.8	223	9.7	13.0	1.0	219	10.7	13.5	0.9	233	10.2	12.9	1.4	241	9.3	9.9
								19.2	0.0		9.9	12.9	0.2		10.4	13.1	0.0		10.5	12.9	0.0	9.3	9.9	
								18.6			9.8	12.8			9.6	12.9			9.7	12.5	1.4	235	9.1	
																					0.0			
5/1 1830	41.1	.23	0.1	-0.1	0.4	234	10.1	12.9	0.6	210	9.7	12.6	0.8	206	11.1	13.5	0.8	232	10.1	12.5	0.9	228	9.3	9.9
								19.3	0.0		10.0	12.6	0.2		11.0	13.2	0.0		10.5	12.6	0.0	9.4	9.9	
								18.8			10.0	12.6			10.2	13.1			9.8	12.3	1.1	224	9.2	
																					0.0			
5/1 1900	40.9	.25	0.0	-0.2	0.4	252	9.9	13.0	0.6	266	9.9	12.8	0.4	261	10.2	12.9	0.7	277	10.0	12.0	0.9	276	9.3	10.0
								18.4	0.1		10.1	12.8	0.1		10.4	12.8	0.0		9.9	12.2	0.0	9.4	9.9	
								18.1			10.1	12.7			9.7	12.8			9.4	12.1	0.9	271	9.2	
																					0.0			
5/1 1930	40.6	.33	0.0	-0.2	4.5	V	8.6	11.0	2.5	248	8.7	10.8	4.1	249	10.1	11.9	3.4	253	9.3	10.7	5.3	253	8.8	9.3
								20.2	0.1		8.9	10.9	0.5		9.5	11.3	-0.1		9.1	10.8	0.0	8.8	9.3	
								18.2			8.8	10.9			8.7	11.2			8.5	10.5	5.8	251	8.7	
																					-0.1			
5/1 2000	40.1	.31	0.0	-0.2	3.1	252	7.6	8.7	1.4	270	8.5	9.0	1.6	257	8.7	9.6	1.5	269	7.6	8.1	2.3	270	8.1	8.3
								19.9	0.1		8.3	8.9	0.2		8.1	8.8	-0.1		7.6	8.2	0.0	8.1	8.3	
								17.8			7.9	8.9			7.4	8.7			7.1	7.9	2.7	267	8.0	
																					0.0			
5/1 2030	39.9	.28	0.0	-0.2	1.3	000	8.1	8.8	1.4	003	8.8	8.7	1.0	031	7.2	8.2	1.1	000	7.6	8.0	1.7	013	8.0	8.1
								20.7	0.1		8.6	9.1	0.0		7.3	8.1	0.0		7.7	8.3	0.0	8.0	8.1	
								19.6			8.1	9.1			7.2	8.3			7.3	8.1	2.2	008	7.9	
																					0.0			
5/1 2100	39.8	.25	0.0	-0.2	0.9	072	7.8	8.6	1.2	094	7.1	7.3	1.1	094	7.0	7.9	1.1	087	8.6	8.8	1.7	093	7.9	8.0
								20.0	0.0		7.3	8.0	0.0		7.1	7.8	0.1		8.3	8.8	-0.1	7.9	8.0	
								18.6			7.2	8.2			7.0	8.1			7.8	8.1	2.2	090	7.8	
																					0.0			

5/1 2130	39.6	.26	0.0	-0.2	0.4	V	7.8	8.2 17.4 15.5	0.7 0.0	207	7.2 7.3 7.1	7.8 7.7 7.9	0.8 0.1	194	8.4 8.1 7.8	9.1 8.5 8.7	0.7 0.0	226	8.0 7.8 7.4	8.1 8.2 7.7	1.2 0.0 1.5	213 198	7.8 7.8 7.8	8.0 8.0 8.0
5/1 2200	39.4	.26	0.0	-0.2	0.4	288	7.5	7.9 18.3 16.2	1.2 0.1	286	8.1 7.8 7.3	8.3 8.2 8.1	0.8 0.0	296	7.6 7.4 7.0	8.2 7.7 8.0	1.0 0.0	291	6.8 6.9 6.6	7.0 7.1 7.1	1.9 0.0 2.1	282 274	7.8 7.8 7.8	7.9 7.9 8.2
5/1 2230	39.2	.28	0.0	-0.2	0.9	276	6.9	7.2 18.9 16.4	1.4 0.1	287	7.5 7.2 6.7	7.6 7.5 7.5	1.1 0.1	292	7.2 7.0 6.5	7.9 7.3 7.4	1.3 0.0	289	6.2 6.3 6.1	6.3 6.4 6.5	2.6 0.0 2.9	286 277	7.6 7.7 7.7	7.7 7.8 8.2
5/1 2300	39.0	.30	0.0	-0.2	1.3	306	6.0	6.3 19.9 17.6	1.8 0.1	311	7.5 7.1 6.5	7.5 7.2 7.1	1.0 0.0	324	5.7 5.6 5.4	6.3 6.0 6.2	1.3 0.0	309	5.4 5.6 5.4	5.5 5.7 5.7	1.8 0.0 2.0	310 305	7.2 7.3 7.3	7.2 7.3 7.4
5/1 2330	38.8	.27	0.0	-0.2	0.4	V	6.9	7.2 17.6 15.7	0.3 0.0	134	6.0 6.1 5.9	6.4 6.2 6.5	0.6 0.1	121	6.3 6.3 6.2	7.1 6.7 7.1	0.1 0.1	183	6.3 6.3 6.1	6.3 6.5 6.3	0.5 0.0 0.6	142 128	7.2 7.3 7.3	7.3 7.3 7.4
5/2 0000	38.6	.26	0.0	-0.2	0.0	V	7.2	7.4 16.6 15.0	0.2 0.0	169	5.6 5.8 5.7	6.2 6.0 6.5	0.6 0.1	120	5.8 6.0 6.1	6.4 6.2 6.8	0.4 0.1	257	5.6 5.8 5.6	5.6 6.0 5.9	0.5 0.0 0.7	185 174	7.0 7.1 7.1	7.1 7.2 7.3
5/2 0030	38.5	.28	0.0	-0.2	0.0	V	6.8	6.9 16.3 14.5	0.4 0.0	160	5.3 5.4 5.4	6.0 5.9 6.1	0.8 0.1	138	5.9 5.9 5.9	6.6 6.1 6.6	0.5 0.1	214	5.3 5.6 5.4	5.3 5.7 5.7	1.0 0.0 1.4	178 179	6.9 7.0 7.0	6.9 7.0 7.2
5/2 0100	38.4	.26	0.0	-0.2	0.0	V	6.7	6.8 16.6 14.7	0.3 0.0	213	5.7 5.8 5.7	6.4 6.3 6.5	0.5 0.1	168	6.7 6.6 6.5	7.3 6.9 7.2	0.5 0.0	248	5.7 6.0 5.7	5.7 6.0 5.9	1.0 0.0 1.3	199 192	7.1 7.2 7.2	7.2 7.2 7.3

5/2 0130	38.2	.27	0.0	-0.2	0.0	V	6.6	6.7 16.2 14.4	0.2 0.0	223	5.8 5.8 5.7	6.4 6.2 6.5	0.3 0.1	141	6.0 6.1 6.2	6.6 6.3 6.7	0.4 0.0	253	5.0 5.4 5.2	5.0 5.5 5.5	0.6 0.0 0.8 0.0	207 205	6.9 7.0 7.0 7.1	6.9 7.0 7.1
5/2 0200	38.0	.30	0.0	-0.2	0.0	V	6.3	6.4 16.3 14.3	0.4 0.0	236	5.5 5.6 5.4	6.0 6.0 6.2	0.5 0.1	205	6.5 6.3 6.2	6.9 6.5 6.7	0.7 0.0	261	4.9 5.2 5.0	4.9 5.2 5.3	0.8 0.0 1.2 0.0	225 210	6.8 6.9 6.9 7.0	6.9 6.9 7.0
5/2 0230	37.9	.30	0.0	-0.2	0.4	V	5.4	5.5 18.3 16.1	1.2 0.1	306	6.5 6.3 5.8	7.2 6.3 6.4	0.7 0.0	326	4.8 4.8 4.9	5.3 5.0 5.4	1.1 0.0	308	4.1 4.3 4.5	4.1 4.5 4.9	1.6 0.0 1.5 0.0	304 305	6.7 6.9 7.0 7.3	6.8 7.1 7.3
5/2 0300	37.7	.30	0.0	-0.2	0.4	V	5.0	5.2 17.3 15.3	0.4 0.0	283	5.0 4.9 4.6	5.7 5.0 5.4	0.2 0.0	014	4.2 4.3 4.2	4.8 4.5 4.9	0.5 0.0	304	3.9 4.0 4.0	3.9 4.2 4.4	0.5 0.0 0.7 0.0	300 302	6.3 6.4 6.5 6.7	6.4 6.5 6.7
5/2 0330	37.5	.29	0.0	-0.2	0.4	270	4.2	4.3 16.2 13.8	0.8 0.0	273	4.5 4.3 3.9	5.2 4.4 4.7	1.0 0.1	270	4.9 4.7 4.3	5.5 4.9 5.1	1.2 0.0	279	2.9 3.1 3.2	2.9 3.3 3.5	1.7 0.0 1.8 0.0	265 252	6.1 6.3 6.5 6.7	6.1 6.4 6.7
5/2 0400	37.4	.30	0.0	-0.2	0.4	281	3.8	3.9 15.8 13.6	0.8 0.0	271	3.8 3.7 3.5	4.6 3.9 4.3	0.7 0.1	267	4.3 4.1 3.9	5.2 4.2 4.6	1.0 0.0	279	2.2 2.5 2.6	2.2 2.6 2.9	1.6 0.0 1.8 0.0	267 259	5.9 6.1 6.1 6.3	5.9 6.1 6.3
5/2 0430	37.2	.29	0.0	-0.2	0.4	270	3.5	3.6 15.4 13.1	0.6 0.0	262	3.0 3.1 3.0	3.8 3.1 3.7	0.6 0.1	265	3.9 3.8 3.6	5.0 4.0 4.4	0.9 0.0	272	1.6 1.9 2.2	1.6 2.1 2.5	1.2 0.0 1.3 0.0	273 276	5.6 5.8 5.8 6.0	5.7 5.9 6.0
5/2 0500	---	---	---	---	0.0	V	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.5 0.0 0.6 0.0	234 252	5.3 5.4 5.4 5.6	5.4 5.4 5.6

5/2 0930	36.0	.28	1.3	0.5	1.3	036	8.1	11.0 24.2 22.8	2.0 0.1	029	8.5 8.5 8.3	10.9 10.8 10.6	2.0 0.0	038	8.4 8.6 7.8	11.6 11.1 10.8	1.8 0.0	028	8.9 9.1 8.3	11.5 11.3 10.8	2.2 -0.1 2.3 0.0	041 038	8.6 8.6 8.4	9.1 9.0 9.1
5/2 1000	36.0	.27	1.5	0.6	1.3	036	8.5	11.9 24.9 24.9	2.1 0.0	034	8.8 8.7 8.7	11.7 11.6 11.3	2.1 0.0	038	8.9 9.2 8.2	12.7 12.1 11.7	2.0 0.0	030	9.4 9.6 8.8	12.5 12.2 11.7	2.5 -0.1 2.6 0.0	043 039	8.9 8.9 8.6	9.5 9.4 9.4
5/2 1030	36.0	.21	1.7	0.8	1.8	036	8.7	12.5 25.3 25.3	2.0 0.1	019	9.0 9.0 9.0	12.3 12.1 12.0	2.0 0.0	032	9.2 9.5 8.4	13.4 12.8 12.4	1.9 0.0	020	9.7 10.0 9.1	13.4 13.0 12.5	2.3 0.0 2.4 0.0	020 018	9.1 9.1 8.9	9.9 9.7 9.8
5/2 1100	36.0	.19	1.8	0.8	1.8	054	9.0	13.3 25.5 25.4	2.0 0.0	039	9.2 9.3 9.4	13.2 13.0 12.8	2.1 0.0	051	9.4 9.8 8.6	14.3 13.6 13.2	1.8 0.0	042	10.0 10.4 9.5	14.1 13.7 13.3	2.5 -0.2 2.6 -0.1	052 051	9.4 9.4 9.1	10.3 10.2 10.2
5/2 1130	35.8	.19	1.0	0.2	1.3	V	8.5	12.9 22.2 22.2	0.5 0.0	000	8.7 9.0 9.1	12.9 12.8 12.7	0.5 0.1	057	8.9 9.3 8.3	13.4 13.1 12.9	0.4 0.0	018	9.3 9.9 9.0	13.3 13.1 12.8	0.8 -0.1 0.8 -0.1	023 016	9.2 9.3 9.0	10.1 10.0 10.1
5/2 1200	35.6	.27	0.3	0.1	1.8	288	8.4	11.4 21.9 20.7	1.7 0.1	283	9.1 9.1 8.9	11.6 11.5 11.3	1.5 0.2	288	9.4 9.2 8.3	11.9 11.5 11.4	1.8 -0.1	292	9.3 9.4 8.6	11.4 11.3 11.0	2.5 0.1 2.7 0.0	294 203	8.9 8.9 8.6	9.4 9.4 9.4
5/2 1230	35.5	.36	0.4	0.3	1.8	252	8.4	11.3 21.7 20.5	1.9 0.1	303	9.0 8.9 8.8	11.4 11.3 11.2	1.3 0.2	292	9.5 9.2 8.4	11.8 11.4 11.3	1.7 -0.1	296	9.3 9.4 8.6	11.3 11.3 11.0	2.2 0.0 2.3 0.0	300 297	8.9 8.9 8.6	9.4 9.3 9.4
5/2 1300	35.4	.33	0.7	0.2	1.3	V	9.0	12.3 21.8 20.9	1.6 0.1	286	9.5 9.5 9.5	12.4 12.3 12.2	1.2 0.2	278	9.9 9.8 8.8	12.9 12.4 12.2	1.5 0.0	278	10.0 10.3 9.4	12.6 12.5 12.2	2.3 0.0 2.3 0.0	282 282	9.3 9.2 9.0	9.9 9.8 9.8

5/2 1330	35.4	.30	0.6	0.2	0.9	V	9.5	13.3 21.1 22.1	1.1 0.0	251	9.6 9.9 10.0	13.3 13.3 13.2	1.2 0.2	244	10.3 10.4 9.3	13.9 13.5 13.4	1.3 0.0	257	10.1 10.6 9.8	13.5 13.5 13.2	1.8 0.0 1.9 -0.1	258 256	9.5 9.5 9.3	10.3 10.2 10.2
5/2 1400	35.2	.32	0.6	0.2	1.8	281	9.2	13.3 22.8 23.4	2.3 0.2	307	9.9 9.9 9.9	13.5 13.3 13.2	1.7 0.1	302	10.9 10.2 9.1	13.9 13.6 13.4	2.0 -0.1	303	10.2 10.6 9.7	13.7 13.6 13.2	2.8 0.1 2.8 0.0	309 308	9.6 9.5 9.3	10.3 10.2 10.2
5/2 1430	35.1	.34	0.5	0.1	1.8	V	9.2	13.0 21.6 21.5	1.8 0.1	261	9.3 9.6 9.7	12.9 12.9 12.8	2.2 0.3	256	10.5 10.3 9.2	13.8 13.3 13.1	2.1 -0.1	262	9.6 10.2 9.4	12.9 12.9 12.7	2.9 0.0 3.1 -0.1	268 266	9.4 9.4 9.2	10.2 10.1 10.1
5/2 1500	35.2	.24	0.9	0.5	0.9	079	9.6	14.2 22.3 24.0	1.1 0.0	077	9.5 9.8 10.0	13.8 13.8 13.7	1.2 0.0	083	9.8 10.2 9.2	14.3 14.0 14.0	1.0 0.1	072	10.3 10.8 10.0	14.1 14.1 13.8	1.3 -0.1 1.4 0.0	083 083	9.8 9.8 9.5	10.6 10.6 10.6
5/2 1530	35.2	.21	1.0	0.7	1.3	V	9.8	15.5 24.6 26.7	1.3 0.0	072	9.9 10.2 10.5	15.3 15.2 15.0	1.6 0.0	076	10.1 10.7 9.4	15.9 15.5 15.3	1.3 0.1	071	10.7 11.4 10.5	15.6 15.5 15.3	1.4 -0.1 1.5 0.0	064 062	10.0 10.1 9.7	11.1 11.0 11.1
5/2 1600	35.2	.19	1.1	0.4	0.9	V	10.0	15.6 24.7 25.1	0.5 0.0	330	10.0 10.5 10.7	15.5 15.5 15.4	0.1 0.1	351	10.5 11.1 9.7	16.2 15.9 15.7	0.6 0.0	306	10.7 11.4 10.5	15.9 15.8 15.5	0.5 0.0 0.5 0.0	313 313	10.1 10.1 9.8	11.2 11.1 11.1
5/2 1630	35.1	.21	1.3	0.7	2.2	281	10.3	16.1 25.5 25.7	3.7 0.2	277	10.7 11.1 11.4	16.4 16.3 16.2	4.1 0.5	269	11.6 11.8 10.4	17.3 16.7 16.7	3.9 -0.2	272	11.8 12.2 11.0	17.1 16.9 16.3	5.4 0.1 5.8 -0.1	274 273	10.3 10.2 9.9	11.4 11.2 11.2
5/2 1700	34.9	.25	1.1	0.5	4.0	281	9.9	15.9 24.1 25.4	3.9 0.2	281	10.2 10.5 10.9	16.1 16.0 15.9	4.1 0.4	274	11.2 11.4 10.1	17.2 16.6 16.4	4.0 -0.2	276	11.3 11.7 10.6	16.8 16.6 16.1	5.4 0.1 5.7 -0.1	283 282	10.2 10.2 9.8	11.4 11.2 11.2

5/2 1730	34.7	.28	0.5	0.1	2.7	277	9.5	15.4 21.8 1730	2.1 0.1	279	9.7 10.1 10.5	15.5 15.5 15.4	2.2 0.3	272	10.5 10.8 9.6	16.3 15.8 15.6	2.4 -0.1	274	10.4 11.0 10.0	15.7 15.6 15.3	3.4 0.0 -0.1	276	10.0 10.0 9.6	11.1 11.3 11.0
5/2 1800	34.5	.31	0.3	0.0	1.8	270	9.3	15.0 21.9 23.7	1.8 0.1	271	9.5 9.8 10.2	15.1 15.0 15.0	2.3 0.3	261	10.4 10.6 9.3	15.7 15.3 15.1	2.2 -0.1	267	9.9 10.6 9.7	15.0 15.0 14.8	3.1 0.0 3.3	270	9.8 9.8 9.8	10.9 10.8 10.9
5/2 1930	34.4	.33	0.2	-0.1	0.9	277	9.0	14.6 22.1 23.4	1.5 0.1	290	9.4 9.7 10.0	14.7 14.7 14.6	1.4 0.1	281	9.6 10.0 8.9	15.0 14.7 14.6	1.6 -0.1	283	9.6 10.3 9.5	14.5 14.6 14.4	2.5 0.0 2.6	281	9.7 9.7 9.4	10.7 10.7 10.7
5/2 1900	34.3	.33	0.1	-0.1	0.9	306	8.9	13.8 22.3 22.6	0.5 0.1	352	9.0 9.3 9.7	13.6 13.7 13.7	0.5 0.0	041	8.8 9.4 8.5	13.6 13.5 13.6	0.5 0.0	347	9.6 10.0 9.2	13.6 13.7 13.5	0.7 0.0 0.8	001	9.4 9.5 9.2	10.4 10.3 10.4
5/2 1930	34.2	.35	0.0	-0.2	1.3	065	8.3	12.3 21.2 21.8	2.2 0.0	042	8.3 8.6 8.9	12.0 12.1 12.1	2.1 0.0	049	7.9 8.5 8.0	11.9 11.9 12.1	1.9 0.0	036	9.0 9.3 8.6	12.1 12.2 12.0	2.6 -0.1 2.9	047	9.0 8.6 8.5	9.8 9.1 9.2
5/2 2000	34.0	.37	0.0	-0.2	1.3	043	7.8	10.7 20.2 20.6	2.4 0.1	025	8.0 8.2 8.2	10.7 10.6 10.6	2.3 0.0	035	7.3 7.8 7.4	10.3 10.3 10.6	2.2 0.0	023	8.1 8.4 7.9	10.4 10.5 10.4	2.4 0.0 2.8	030	8.6 8.6 8.5	9.1 9.1 9.2
5/2 2030	33.8	.33	0.0	-0.2	0.9	018	7.2	9.3 20.3 20.3	1.7 0.1	006	7.9 7.9 7.7	9.5 9.4 9.4	1.5 0.0	027	6.7 7.0 6.8	8.8 8.8 9.1	1.3 0.0	004	7.3 7.6 7.2	8.9 9.0 8.9	2.3 0.0 3.0	011	8.2 8.3 8.1	8.6 8.6 8.7
5/2 2100	33.6	.35	0.0	-0.2	0.4	000	6.3	8.1 19.3 18.1	1.5 0.1	317	7.4 7.2 6.8	8.5 8.4 8.3	0.6 0.0	347	5.9 6.1 5.9	7.6 7.6 7.9	1.1 0.0	314	6.2 6.5 6.2	7.4 7.6 7.6	2.3 0.1 3.0	337	7.8 7.9 7.8	8.1 8.2 8.3

5/2 2130	33.5	.34	0.0	-0.2	0.4	306	5.7	6.6 18.6 16.8	1.7 0.2	305	6.3 6.2 5.7	7.0 6.9 6.8	0.8 0.1	315	5.3 5.4 5.0	6.6 6.5 6.7	1.1 0.0	299	5.0 5.3 5.0	5.9 6.1 6.0	2.6 0.0 3.2 0.0	307 320	6.9 7.1 7.2	7.1 7.3 7.7
5/2 2100	33.4	.36	0.0	-0.2	0.4	313	5.3	6.7 18.8 17.2	1.5 0.1	303	6.3 6.2 5.8	7.0 7.0 6.9	0.8 0.0	312	5.3 5.4 5.0	6.7 6.6 6.7	1.1 0.0	301	5.1 5.4 5.2	6.0 6.2 6.2	2.6 0.0 3.3 0.0	304 318	7.1 7.2 7.3	7.3 7.4 7.9
5/2 2230	33.3	.33	0.0	-0.2	0.4	302	4.8	6.1 18.7 16.9	1.4 0.1	297	5.5 5.4 5.2	6.3 6.3 6.3	1.1 0.0	303	4.8 4.8 4.5	6.0 5.8 6.0	1.1 0.0	297	4.5 4.8 4.6	5.2 5.5 5.5	2.9 0.0 3.1 0.0	295 301	6.8 7.0 7.3	7.1 7.3 7.9
5/2 2100	33.2	.33	0.0	-0.2	0.4	288	4.6	5.8 18.1 16.2	1.2 0.1	280	4.9 4.8 4.7	5.7 5.7 5.7	1.0 0.1	279	5.2 5.0 4.5	6.1 5.9 5.9	1.2 0.0	281	4.3 4.6 4.4	5.0 5.2 5.3	2.4 0.0 3.0 0.0	282 276	6.5 6.7 6.8	6.8 6.9 7.3
5/2 2330	33.1	.30	0.0	-0.2	0.4	299	4.9	6.3 19.2 17.3	1.5 0.0	286	5.4 5.2 5.0	6.2 6.1 6.1	1.4 0.1	289	5.4 5.3 4.9	6.6 6.4 6.4	1.5 0.0	288	4.8 5.1 4.9	5.6 5.8 5.9	2.7 0.0 3.4 0.0	285 275	6.7 6.9 7.0	6.9 7.1 7.5
5/3 0000	33.0	.28	0.0	-0.2	0.4	V	4.6	5.6 17.5 15.8	0.6 0.0	199	4.3 4.4 4.4	5.2 5.2 5.3	0.8 0.2	186	5.3 5.1 4.8	6.1 5.9 5.9	0.6 0.1	215	4.7 4.9 4.5	5.2 5.4 5.2	1.1 0.0 1.1 0.0	215 226	6.4 6.5 6.5	6.6 6.6 6.8
5/3 0030	32.8	.29	0.0	-0.2	0.0	V	4.8	5.9 17.1 15.7	0.4 0.0	206	4.3 4.4 4.4	5.2 5.3 5.4	0.8 0.1	172	5.1 5.0 4.8	6.0 6.0 6.0	0.5 0.0	232	4.7 4.8 4.4	5.3 5.4 5.3	1.3 0.0 1.8 0.0	194 182	6.5 6.6 6.5	6.7 6.8 7.0
5/3 0100	32.7	.31	0.0	-0.2	0.0	V	5.1	6.1 17.8 16.4	0.2 0.0	237	4.6 4.8 4.7	5.7 5.6 5.6	0.4 0.1	220	5.0 5.0 4.7	6.0 5.9 6.0	0.6 0.0	260	4.8 5.0 4.7	5.4 5.6 5.5	1.0 0.0 1.5 0.0	225 210	6.6 6.6 6.6	6.8 6.8 6.9

5/3 0130	32.6	.32	0.0	-0.2	0.0	V	5.0	5.8 17.2 15.8	0.4	203	4.4 4.5 4.5	5.1 5.2 5.3	0.6 0.1	186	5.3 5.2 5.0	6.1 5.9 6.0	0.5 0.1	232	4.8 4.9 4.6	5.2 5.3 5.2	1.0 0.0 1.0	215 221 221	6.5 6.6 6.6	6.7 6.7 6.8
5/3 0200	32.5	.31	0.0	-0.2	0.0	V	4.8	5.6 17.7 15.9	0.7	253	4.7 4.8 4.7	5.3 5.4 5.5	0.7 0.1	281	5.2 5.0 4.7	5.8 5.7 5.8	0.9 0.0	268	4.2 4.4 4.3	4.6 4.9 5.0	1.5 0.0 1.8	254 246 246	6.5 6.6 6.6	6.7 6.8 7.0
5/3 0230	32.4	.31	0.0	-0.2	0.0	V	4.9	5.8 18.0 16.3	0.8	232	4.6 4.8 4.7	5.4 5.5 5.6	1.1 0.2	229	5.7 5.4 5.0	6.3 6.1 6.0	1.0 0.0	254	4.6 4.8 4.5	5.1 5.2 5.2	2.1 0.0 2.7	238 233 233	6.7 6.7 6.7	6.9 6.9 7.0
5/3 0300	32.3	.28	0.0	-0.2	0.0	V	4.9	5.8 18.1 16.3	0.7	244	4.6 4.8 4.7	5.3 5.4 5.5	0.7 0.1	229	5.3 5.1 4.9	6.1 5.9 6.0	0.7 0.0	256	4.6 4.7 4.4	5.0 5.2 5.1	1.5 0.0 1.9	250 249 249	6.6 6.7 6.6	6.8 6.8 7.0
5/3 0330	32.2	.31	0.0	-0.2	0.0	V	5.1	6.2 17.9 16.3	0.6	265	5.1 5.0 5.0	5.9 6.0 5.9	0.8 0.1	248	5.6 5.5 5.1	6.5 6.3 6.3	0.8 0.0	265	4.6 4.9 4.7	5.2 5.5 5.5	1.5 0.0 1.9	258 252 252	6.7 6.8 6.7	6.9 6.9 7.0
5/3 0400	32.1	.29	0.0	-0.2	0.0	V	4.7	5.7 17.4 16.0	0.6	275	4.7 4.7 4.6	5.4 5.4 5.5	0.2 0.1	265	4.8 4.8 4.5	5.7 5.6 5.7	0.6 0.0	276	4.3 4.5 4.2	4.8 5.0 5.0	1.1 0.0 1.4	290 300 300	6.5 6.5 6.6	6.6 6.7 7.0
5/3 0430	32.0	.30	0.0	-0.2	0.0	V	5.0	6.2 17.3 16.0	0.3	255	4.5 4.6 4.7	5.4 5.6 5.8	0.1 0.1	172	4.8 5.0 5.0	5.8 5.9 6.3	0.6 0.0	269	4.3 4.7 4.6	5.0 5.6 5.7	0.6 0.0 0.7	233 224 224	6.6 6.7 6.6	6.8 6.9 7.0
5/3 0500	31.8	.33	0.0	-0.2	0.0	V	4.4	5.1 16.8 15.4	0.4	233	3.9 4.1 4.0	4.5 4.6 4.7	0.5 0.1	200	4.8 4.8 4.6	5.4 5.4 5.5	0.6 0.0	165	3.7 3.9 3.8	4.1 4.4 4.4	1.1 0.0 1.6	224 221 221	6.2 6.3 6.3	6.4 6.4 6.6

5/3 0530	31.8	.33	0.0	-0.2	0.0	V	3.9	4.5 17.1 15.4	0.5 0.0	220	3.5 3.6 3.5	4.0 4.1 4.2	0.7 0.1	204	4.5 4.3 4.1	5.1 4.8 4.9	0.7 0.0	247	3.5 3.6 3.5	3.7 3.9 3.9	1.3 0.0 1.8	213 205 205	6.0 6.0 6.1
5/3 0600	31.7	.32	0.0	-0.1	0.0	V	4.4	5.0 16.4 15.3	0.3 0.0	176	3.7 3.8 3.8	4.2 4.4 4.5	0.5 0.1	162	4.6 4.7 4.6	5.3 5.2 5.4	0.3 0.0	228	4.0 4.2 3.9	4.4 4.5 4.3	1.3 0.0 1.5	252 234 234	6.1 6.2 6.4
5/3 0630	31.6	.29	0.0	-0.1	0.0	V	4.8	5.5 17.6 16.2	0.4 0.0	235	4.4 4.5 4.4	5.0 5.1 5.1	0.6 0.1	210	5.1 5.0 4.8	5.8 5.6 5.7	0.5 0.0	257	4.4 4.6 4.3	4.8 5.0 5.9	1.2 0.0 1.5	238 234 234	6.4 6.4 6.7
5/3 0700	31.5	.31	0.1	0.0	0.0	V	5.4	6.3 18.1 16.9	0.4 0.0	236	5.1 5.2 5.1	5.9 5.9 5.9	0.5 0.1	212	5.7 5.6 5.3	6.5 6.4 6.4	0.6 0.0	252	5.3 5.4 5.0	5.8 5.9 5.7	0.8 0.0 0.9	250 254 254	6.7 6.9 7.1
5/3 0730	31.5	.28	0.2	0.0	0.0	V	6.9	8.5 19.0 18.5	0.5 0.0	201	6.2 6.4 6.5	7.9 7.9 8.0	0.8 0.1	178	6.8 6.8 6.4	8.5 8.3 8.3	0.5 0.0	208	7.1 7.3 6.7	8.3 8.4 8.1	0.8 0.0 0.8	245 245 245	7.3 7.3 7.2
5/3 0800	31.4	.27	0.4	0.0	0.0	V	6.8	8.8 19.1 18.8	0.5 0.0	191	6.4 6.6 6.7	8.4 8.5 8.5	0.7 0.1	177	7.1 7.2 6.8	9.1 8.9 8.9	0.5 0.0	219	7.2 7.3 6.8	8.7 8.8 8.5	0.7 0.0 0.6	205 212 212	7.7 8.1 7.6
5/3 0830	31.4	.27	0.6	0.2	0.0	V	7.1	9.8 19.4 20.8	0.3 0.0	094	6.8 7.0 7.1	9.4 9.4 9.5	0.7 0.0	097	6.7 7.1 6.6	9.6 9.5 9.6	0.1 0.1	044	7.4 7.7 7.1	9.6 9.7 9.4	0.0 0.0 0.1	058 025 025	8.1 8.6 8.6
5/3 0900	31.4	.26	0.9	0.3	0.4	072	7.6	11.0 21.2 23.4	1.1 0.0	078	7.5 7.7 7.9	10.5 10.5 10.5	1.3 0.0	081	7.6 7.9 7.4	11.0 10.8 10.8	1.0 0.1	072	8.5 8.5 7.9	10.8 10.8 10.6	1.3 -0.1 1.4	077 076 076	8.6 9.2 8.4

5/3 1030	31.5	.22	1.2	0.5	0.9	0.90	8.3	11.9 22.5 25.2	1.6	0.76	8.2	11.5 8.3 11.4 8.4 11.3	1.8	0.78	8.6	12.3 8.7 11.9 8.1 11.8	1.5	0.72	9.4	12.0 9.3 11.9 8.6 11.6	2.0	0.79	9.0	9.7 9.0 9.6 8.8 9.7
5/3 1000	31.6	.17	1.4	0.6	1.3	1.82	8.7	13.1 23.4 26.4	1.5	0.54	8.8	13.0 9.0 12.8 9.2 12.7	1.7	0.58	9.2	13.9 9.5 13.4 8.6 13.1	1.5	0.49	10.1	13.5 10.0 13.3 9.1 12.9	1.6	0.57	9.3	10.2 9.3 10.1 9.1 10.1
5/3 1030	31.6	.16	1.1	0.5	1.3	0.90	9.1	13.9 25.1 26.1	2.0	0.75	9.0	13.6 9.2 13.5 9.5 13.3	2.1	0.72	9.5	14.5 9.7 14.0 8.8 13.7	1.8	0.65	10.3	14.0 10.3 13.9 9.5 13.6	2.6	0.71	9.5	10.5 9.6 10.4 9.3 10.4
5/3 1100	31.5	.17	0.9	0.4	1.8	0.54	9.6	14.4 25.1 26.2	2.8	0.26	9.3	14.1 9.5 14.0 9.8 13.8	2.8	0.37	9.7	15.0 10.0 14.5 9.0 14.2	2.5	0.29	10.6	15.0 10.7 14.8 9.8 14.3	2.8	0.26	9.6	10.6 9.6 10.5 9.3 10.5
5/3 1130	31.3	.25	0.5	0.1	3.1	0.36	8.9	13.5 23.3 24.4	3.9	0.08	9.6	13.5 9.4 13.4 9.6 13.3	3.5	0.19	9.0	13.8 9.5 13.5 8.6 13.4	3.4	0.11	9.8	13.9 10.1 13.7 9.2 13.3	4.6	0.13	9.4	10.2 9.4 10.2 9.1 10.2
5/3 1200	31.2	.22	0.6	0.3	3.1	0.36	9.0	13.6 22.0 24.7	4.1	0.17	9.2	13.5 9.4 13.4 9.6 13.3	3.9	0.26	9.2	14.0 9.6 13.6 8.7 13.4	3.8	0.20	10.0	13.9 10.2 13.7 9.3 13.3	4.4	0.26	9.4	10.3 9.4 10.2 9.2 10.2
5/3 1230	31.0	.21	0.7	0.1	3.6	0.43	8.9	13.1 21.0 23.8	4.4	0.1	9.0	13.0 9.3 13.0 9.5 12.9	4.5	0.37	9.1	13.3 9.4 13.0 8.7 12.9	4.1	0.31	9.9	13.4 10.1 13.3 9.3 13.0	4.9	0.36	9.4	10.2 9.5 10.1 9.2 10.2
5/3 1300	30.9	.20	0.3	0.1	4.5	0.36	8.4	11.6 21.4 22.4	5.3	0.20	8.6	11.6 8.7 11.5 8.8 11.4	4.9	0.26	8.4	11.7 8.7 11.5 8.1 11.5	4.8	0.21	9.2	11.8 9.3 11.7 8.7 11.4	5.7	0.27	8.9	9.5 9.0 9.5 8.7 9.5

5/3 1330	30.8	.17	0.5	0.3	3.6	029	8.4	10.8	4.5	026	8.6	10.6	4.1	032	8.6	10.9	4.1	025	9.1	11.0	4.7	035	8.7	9.2
							22.4	22.4	0.1		8.6	10.6	-0.1		8.6	10.7	-0.1		9.2	10.9	-0.1	8.7	9.1	
							21.9				8.6	10.5			8.1	10.7			8.5	10.6	0.0	8.6	9.1	
5/3 1400	30.7	.17	0.8	0.3	4.0	016	8.3	11.6	4.5	024	8.5	11.4	4.3	030	8.4	11.9	4.1	023	9.1	12.0	5.1	029	8.8	9.4
							22.7	22.7	0.1		8.5	11.4	-0.1		8.6	11.6	-0.1		9.2	11.8	-0.1	8.8	9.3	
							23.4				8.6	11.3			8.0	11.4			8.5	11.4	0.0	5.5	023	
																					0.0	8.4	9.3	
5/3 1430	30.5	.17	0.6	0.2	4.5	029	7.7	11.7	5.3	008	8.1	11.5	4.6	018	7.8	11.9	4.4	013	8.6	11.9	6.3	010	8.7	9.4
							20.5	20.5	0.3		8.1	11.5	-0.1		8.1	11.6	-0.2		8.8	11.8	0.0	8.7	9.3	
							23.1				8.2	11.3			7.4	11.5			8.0	11.4	0.1	7.1	006	
																						8.4	9.3	
5/3 1500	30.4	.19	0.3	0.0	2.7	025	6.7	10.2	3.1	014	7.0	10.1	2.8	027	6.8	10.3	2.6	016	7.5	10.3	3.6	015	8.1	8.8
							20.9	20.9	0.1		7.1	10.1	-0.1		7.1	10.1	-0.1		7.7	10.3	0.0	8.1	8.7	
							21.8				7.2	10.0			6.5	10.1			7.0	10.0	0.0	4.1	012	
																						7.9	8.7	
5/3 1530	30.4	.21	0.3	0.1	1.3	V	7.3	11.0	0.2	302	7.4	10.8	0.5	231	7.8	11.3	0.6	268	7.9	11.0	0.5	262	8.5	9.2
							20.3	20.3	0.0		7.5	10.8	0.2		7.9	11.1	0.0		8.3	11.1	0.0	8.5	9.1	
							22.0				7.7	10.8			7.1	11.1			7.6	10.8	0.7	264	8.3	
																					0.0		9.2	
5/3 1600	30.3	.25	0.2	0.0	1.3	152	7.0	10.7	1.0	336	7.2	10.6	0.8	317	7.5	11.0	1.0	312	7.6	10.7	1.3	325	8.3	9.0
							20.4	20.4	0.1		7.4	10.6	0.2		7.6	10.7	-0.1		8.0	10.7	-0.1	8.3	9.0	
							21.5				7.6	10.6			6.9	10.7			7.3	10.5	1.5	324	8.1	
																					0.0		9.0	
5/3 1630	30.0	.29	0.1	-0.1	3.1	000	5.7	6.9	4.4	344	6.5	7.2	2.9	356	5.7	6.7	3.6	346	6.2	6.8	4.8	355	7.3	7.6
							21.7	21.7	0.4		6.3	7.1	0.0		5.7	6.7	-0.3		6.3	6.9	0.1	7.3	7.5	
							20.3				6.0	7.0			5.5	6.9			5.8	6.7	5.4	354	7.2	
																					0.0		7.6	
5/3 1700	29.8	.38	0.1	0.0	2.2	000	5.1	6.2	3.4	343	5.9	6.5	2.3	356	5.1	6.0	2.6	345	5.7	6.1	4.3	345	6.8	7.0
							21.6	21.6	0.3		5.7	6.4	0.0		5.0	5.9	-0.2		5.7	6.2	0.2	6.8	7.0	
							20.0				5.3	6.3			4.9	6.2			5.2	6.0	4.8	344	6.7	
																					0.0		7.0	

5/3 1730	29.6	.45	0.2	-0.1	1.3	324	4.6	6.0	1.6	300	5.1	6.0	1.4	295	4.9	6.0	1.6	292	5.1	5.7	2.6	297	6.6	6.8
								20.6	0.1		5.0	5.9	0.1		4.7	5.8	-0.1		5.1	5.8	0.0	6.6	6.8	
								18.7			4.8	5.9			4.4	5.9			4.7	5.6	2.9	296	6.5	
																					0.0		6.9	
5/3 1800	29.5	.38	0.0	-0.1	2.2	281	4.3	5.4	2.2	279	4.7	5.4	2.5	271	5.1	5.9	2.4	274	4.6	5.1	3.7	275	6.4	6.6
								21.0	0.1		4.7	5.4	0.3		4.7	5.5	-0.1		4.7	5.2	0.0	6.4	6.6	
								18.2			4.4	5.3			4.2	5.4			4.3	5.0	4.0	273	6.3	
																					0.0		6.6	
5/3 1830	29.5	.38	0.0	-0.1	1.3	245	4.3	5.3	1.6	204	4.4	5.0	2.0	198	5.2	5.9	1.7	212	4.7	5.1	3.0	196	6.1	6.2
								18.8	0.0		4.4	5.0	0.3		4.7	5.5	0.0		4.7	5.2	-0.1	6.1	6.2	
								17.3			4.2	5.0			4.3	5.4			4.3	4.9	3.3	19 ^c	6.0	
																					0.0		6.2	
5/3 1900	29.3	.41	0.0	-0.1	1.3	176	4.2	5.0	1.8	143	4.3	4.8	2.1	139	4.5	5.6	1.5	141	5.3	5.5	2.5	148	6.2	6.3
								20.5	0.0		4.3	4.8	0.1		4.3	5.0	0.2		5.1	5.4	-0.1	6.2	6.3	
								18.5			4.2	4.9			4.0	5.0			4.5	5.0	2.8	145	6.1	
																					-0.1		6.3	
5/3 1930	29.3	.39	0.0	-0.1	1.3	104	4.2	5.1	1.6	090	4.2	4.8	1.7	085	4.0	4.8	1.4	081	5.0	5.3	2.0	090	6.2	6.3
								20.3	0.0		4.2	4.8	0.0		4.0	4.7	0.1		4.9	5.2	-0.1	6.2	6.3	
								18.9			4.1	4.9			3.9	5.0			4.4	4.9	2.5	090	6.2	
																					0.0		6.4	
5/3 2000	29.2	.34	0.0	-0.1	0.4	V	4.2	5.2	0.4	257	4.2	4.9	0.5	240	4.5	5.3	0.6	267	4.4	4.8	1.0	259	6.3	6.4
								18.7	0.0		4.3	4.9	0.1		4.3	5.1	0.0		4.5	5.0	0.0	6.3	6.4	
								17.4			4.2	5.0			4.0	5.2			4.2	4.8	1.1	253	6.2	
																					0.0		6.5	
5/3 2030	29.1	.33	0.0	-0.1	0.4	274	3.9	5.1	1.5	281	4.4	5.2	1.4	269	4.6	5.5	1.5	275	4.1	4.6	2.0	281	6.2	6.4
								19.0	0.1		4.3	5.1	0.2		4.3	5.2	0.0		4.3	4.8	0.0	6.2	6.4	
								17.3			4.1	5.1			3.9	5.2			3.9	4.7	2.6	276	6.1	
																					0.0		6.5	
5/3 2100	28.9	.36	0.0	-0.1	2.2	288	3.8	5.0	3.8	299	4.4	5.1	3.2	294	4.1	5.1	3.0	295	4.0	4.6	5.2	297	6.2	6.4
								24.6	0.3		4.2	5.1	0.1		4.0	4.9	-0.2		4.2	4.8	0.2	6.2	6.4	
								18.6			4.0	5.0			3.7	5.0			3.9	4.7	6.0	297	6.1	
																					0.0		6.5	

5/3 2130	28.8	.33	0.0	-0.1	2.7	306	3.6	5.0 23.8 18.6	2.9 0.3	301	4.3 3.8 3.8	5.1 5.0 4.5	2.4 0.1	297	3.9 3.8 3.5	5.0 4.9 5.0	2.4 -0.1	296	3.9 4.1 3.7	4.5 4.8 4.7	3.9 0.1 4.6 0.0	301 301	6.1 6.1 6.0	6.3 6.3 6.4
5/3 2200	28.7	.35	0.0	-0.1	1.8	295	3.6	5.4 20.2 17.5	1.5 0.1	291	4.1 3.5 3.7	5.3 5.6 4.8	1.2 0.1	283	4.1 4.0 3.6	5.6 5.5 5.6	1.3 0.0	285	3.8 4.0 3.6	4.8 5.0 5.0	2.3 0.0 2.6 0.0	284 285	6.1 6.2 6.1	6.5 6.5 6.6
5/3 2230	28.7	.32	0.0	-0.1	0.0	V	4.0	5.2 18.8 16.8	0.4 0.0	163	3.7 3.4 4.0	4.6 5.1 4.8	0.8 0.1	146	4.0 3.9 3.7	5.1 5.0 5.1	0.4 0.1	208	4.1 4.3 3.9	4.8 5.0 4.8	0.7 0.0 0.8 0.0	186 187	6.0 6.1 6.0	6.3 6.3 6.3
5/3 2300	28.6	.32	0.0	-0.1	0.0	V	3.9	5.0 19.4 17.7	0.6 0.0	110	3.7 3.0 4.4	4.4 4.6 5.0	0.8 0.0	107	3.6 3.7 3.5	4.6 4.6 4.9	0.5 0.1	102	4.5 4.6 4.2	5.0 5.1 4.9	0.7 0.0 0.9 0.0	136 131	6.0 6.0 5.9	6.2 6.2 6.3
5/3 2330	28.5	.34	0.0	-0.2	0.4	324	3.6	4.5 19.6 17.2	0.2 0.0	054	3.5 2.7 3.6	4.0 4.1 4.1	0.4 0.1	091	3.3 3.4 3.3	4.1 4.1 4.5	0.2 0.0	323	3.7 3.9 3.5	4.1 4.3 4.1	0.3 0.0 0.7 0.0	100 105	5.8 5.8 5.8	5.9 6.0 6.1
5/4 0000	28.4	.36	0.0	-0.2	0.4	317	1.9	2.8 20.0 17.0	1.6 0.1	321	2.9 2.7 2.3	3.2 3.0 3.1	0.9 0.0	341	1.4 1.5 1.7	2.1 2.2 2.8	1.3 0.0	319	1.9 2.0 1.8	2.1 2.3 2.4	2.3 0.0 2.3 0.0	320 320	5.2 5.4 5.5	5.3 5.6 5.9
5/4 0030	28.3	.34	0.0	-0.1	0.0	270	1.8	2.9 20.4 16.5	1.2 0.1	308	2.6 2.4 2.2	3.0 3.0 3.1	0.7 0.0	329	1.6 1.6 1.6	2.4 2.4 3.0	1.0 0.0	308	1.7 1.8 1.6	2.0 2.2 2.3	1.9 0.0 2.1 0.0	298 294	4.9 5.1 5.2	5.1 5.4 5.7
5/4 0100	28.2	.32	0.0	-0.1	0.4	152	2.4	3.8 20.0 15.8	0.7 0.0	139	2.5 2.5 2.5	3.5 3.6 3.7	0.8 0.2	226	2.9 2.7 2.4	4.1 3.9 4.0	0.8 0.0	248	2.4 2.6 2.3	3.1 3.3 3.3	1.5 0.0 1.7 0.0	244 242	5.3 5.4 5.3	5.6 5.6 5.7

5/4 0130	28.1	.32	0.0	-0.1	0.9	288	2.4	3.5	1.4	243	2.6	3.3	2.2	244	3.3	4.1	1.9	250	2.5	3.0	2.9	251	5.3	5.5
								19.3	0.0		2.6	3.4	0.3		2.9	3.7	-0.1		2.7	3.2	0.0		5.4	5.5
								16.3			2.5	3.4			2.5	3.7			2.4	3.1	3.5	248	5.3	5.6
5/4 0200	28.0	.35	0.0	-0.1	0.9	284	2.3	3.4	1.1	285	2.7	3.3	0.8	273	2.7	3.5	1.2	281	2.3	2.7	1.6	292	5.2	5.4
								19.6	0.1		2.7	3.3	0.1		2.5	3.3	0.0		2.5	3.0	0.0		5.2	5.4
								16.6			2.5	3.3			2.2	3.4			2.2	2.9	1.7	286	5.2	5.5
5/4 0230	27.9	.32	0.0	-0.1	0.4	216	2.0	3.3	1.0	275	2.3	3.2	1.0	268	2.6	3.6	1.2	274	2.0	2.6	1.7	274	5.1	5.3
								20.0	0.0		2.2	3.2	0.1		2.4	3.4	0.0		2.2	2.9	0.0		5.1	5.3
								16.0			2.1	3.2			2.0	3.5			1.9	2.8	2.1	274	5.0	5.5
5/4 0300	27.9	.34	0.0	-0.2	0.0	V	1.6	2.6	0.3	206	1.4	1.9	0.5	169	1.9	2.6	0.4	248	1.4	1.8	1.0	211	4.8	5.0
								19.7	0.0		1.4	2.0	0.1		1.8	2.5	0.0		1.6	2.0	0.0		4.9	5.1
								15.5			1.5	2.3			1.6	2.8			1.4	2.0	1.3	211	4.9	5.2
5/4 0330	27.7	.36	0.0	-0.2	0.4	V	1.4	2.3	0.6	292	1.7	2.2	0.4	295	1.3	2.1	0.7	290	1.0	1.4	1.0	275	4.5	4.7
								20.1	0.1		1.7	2.3	0.1		1.3	2.1	0.0		1.3	1.7	0.0		4.6	4.7
								15.5			1.5	2.3			1.1	2.3			1.0	1.7	1.2	264	4.5	4.8
5/4 0400	27.7	.32	0.0	-0.2	0.0	V	1.3	2.7	0.8	256	1.5	2.4	1.0	244	2.0	3.1	1.1	258	1.2	2.0	1.6	254	4.7	4.9
								20.3	0.0		1.5	2.5	0.2		1.8	2.9	0.0		1.5	2.3	0.0		4.8	5.0
								15.5			1.5	2.6			1.4	3.0			1.3	2.3	2.0	247	4.7	5.1
5/4 0430	27.6	.35	0.0	-0.1	0.4	V	1.1	2.4	1.3	301	1.7	2.4	0.9	305	1.3	2.2	1.2	300	1.2	1.7	2.1	292	4.5	4.7
								20.4	0.1		1.6	2.4	0.0		1.2	2.1	0.0		1.3	1.9	0.0		4.6	4.8
								16.2			1.4	2.4			0.9	2.4			1.1	1.9	2.2	293	4.5	5.0
5/4 0500	27.5	.35	0.0	-0.1	0.4	324	1.3	2.9	0.8	296	1.7	2.9	0.3	276	1.5	2.8	0.8	286	1.3	2.2	1.0	287	4.7	5.0
								20.3	0.1		1.7	2.9	0.1		1.4	2.7	0.0		1.6	2.5	0.0		4.8	5.1
								16.2			1.7	3.0			1.2	3.0			1.2	2.5	1.1	288	4.7	5.2
																					0.0			

5/4 0530	27.4	.34	0.0	-0.2	0.4	306	1.2	2.8	0.8	308	1.7	2.8	0.4	341	0.9	2.2	0.7	303	1.0	1.9	0.6	317	4.5	4.8
								20.9	0.1		1.6	2.8	0.0		1.0	2.3	0.0		1.2	2.2	0.0		4.6	4.8
								15.9			1.6	2.9			0.8	2.7			0.9	2.2	1.0	296	4.5	5.0
																					0.0			
5/4 0600	27.2	.37	0.0	-0.2	0.9	306	0.4	2.1	1.3	307	1.0	2.1	0.8	327	0.3	1.9	1.1	302	0.1	1.2	1.4	332	4.4	4.7
								24.1	0.1		0.9	2.1	0.0		0.4	1.9	0.0		0.7	1.6	0.0		4.4	4.7
								15.8			0.9	2.2			0.0	2.3			0.4	1.7	1.6	328	4.3	4.9
																					0.0			
5/4 0630	27.2	.35	0.1	-0.2	0.4	270	0.3	2.0	1.1	294	0.8	1.9	0.7	286	0.6	1.9	1.1	289	0.1	1.2	1.6	281	4.2	4.5
								23.9	0.1		0.7	1.9	0.1		0.6	1.9	0.0		0.6	1.5	0.0		4.3	4.6
								15.6			0.6	2.0			0.3	2.1			0.3	1.5	1.7	281	4.2	4.7
																					0.0			
5/4 0700	27.2	.31	0.2	-0.1	0.4	288	1.4	3.1	0.5	273	1.6	2.9	0.3	241	1.8	3.3	0.6	268	1.7	2.8	---	---	---	---
								24.1	0.0		1.5	3.0	0.1		1.7	3.2	0.0		1.9	3.0	---	---	---	
								16.0			0.6	2.0			2.0	4.6			2.3	4.3	---	---	---	
5/4 0730	27.2	.27	0.6	0.0	0.9	263	1.9	4.3	1.3	272	2.6	4.4	1.6	265	2.7	4.8	1.6	272	2.8	4.4	---	---	---	
								24.7	0.1		2.1	4.8	0.2		2.6	4.6	-0.1		2.9	4.5	---	---	---	
								17.8			2.7	4.8			2.0	4.6			2.3	4.3	---	---	---	
5/4 0800	27.2	.26	1.0	0.3	1.3	266	2.6	5.0	2.0	250	3.5	5.4	3.2	252	3.7	5.8	2.7	257	3.7	5.5	---	---	---	
								24.7	0.1		3.3	5.4	0.5		3.4	5.5	-0.1		3.7	5.5	---	---	---	
								19.0			3.2	5.3			2.7	5.4			3.0	5.1	---	---	---	
5/4 0830	27.1	.25	0.8	0.2	1.8	252	2.1	4.4	2.1	269	2.6	4.5	2.8	262	3.0	5.0	2.6	266	2.9	4.6	---	---	---	
								24.0	0.1		2.5	4.5	0.4		2.7	4.7	-0.1		3.0	4.6	---	---	---	
								18.6			2.5	4.4			2.1	4.6			2.4	4.3	---	---	---	
5/4 0900	27.2	.21	0.8	0.3	1.3	000	2.5	4.8	1.3	257	3.1	5.0	1.7	249	3.2	5.3	1.6	258	3.4	5.2	---	---	---	
								21.9	0.1		2.9	5.0	0.3		1.0	5.0	0.0		3.4	5.1	---	---	---	
								19.3			2.9	4.9			2.4	5.0			2.7	4.7	---	---	---	

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APPENDIX B

Data Volume

Date Time	T	s	Rad Down	Rad Net	Raft				"East"				"North"				"West"				Reference			
					W/S	W/D	Tw	Td	W/S	W/D	Tw	Td	W/S	W/D	Tw	Td	W/S	W/D	Tw	Td	W/S	W/D	Tw	Td
	C	C	Mw	Mw	ms ⁻¹	deg	C	C	ms ⁻¹	deg	C	C	ms ⁻¹	deg	C	C	ms ⁻¹	deg	C	C	ms ⁻¹	deg	C	C
4/27 1000	50.5	.66	1.4	0.4	1.8	036	7.3	13.9 24.1 22.0	2.5 0.1	009	9.0 8.8 8.2	13.8 13.6 13.3	2.3 -0.1	021	6.4 7.1 5.8	14.4 13.9 13.3	2.0 0.0	010	8.4 9.5 8.4	16.0 15.4 14.8	2.6 -0.2 2.8 -0.1	028 025	9.1 9.2 9.0	10.3 10.3 10.5
4/27 1030	50.3	.28	1.7	0.5	2.2	029	7.7	14.5 24.4 22.2	2.7 0.1	010	9.1 8.9 8.2	14.2 14.0 13.7	2.2 0.0	024	6.7 7.5 6.1	15.0 14.4 13.9	2.3 -0.1	013	8.4 9.4 8.3	16.1 15.4 15.0	2.8 0.0 2.9 0.0	016 014	9.3 9.3 9.2	10.5 10.4 10.7
4/27 1100	49.8	.16	1.9	0.7	2.7	029	8.2	15.5 24.2 22.1	2.5 0.1	022	8.8 9.0 8.7	15.0 14.8 14.5	2.4 0.0	038	7.5 8.2 6.7	16.4 15.6 15.0	2.3 0.0	027	9.8 10.7 9.7	17.8 17.1 16.8	2.7 -0.2 2.8 ---	043 040	9.7 9.7 9.3	11.0 10.8 11.0
4/27 1130	49.3	.31	2.0	0.8	2.2	054	8.7	16.2 24.6 22.0	2.4 0.1	041	8.7 9.2 9.1	15.9 15.6 15.3	2.4 0.0	049	8.0 8.8 7.2	17.2 16.4 15.7	2.2 0.0	027	10.3 11.3 10.4	18.4 17.9 17.8	2.9 -0.3 2.9 ---	052 049	9.9 9.9 9.5	11.3 11.3 11.3
4/27 1200	49.0	.27	2.1	0.8	2.2	022	8.9	16.7 25.2 22.0	2.4 0.1	003	9.7 9.9 9.7	16.3 16.1 15.9	2.0 -0.1	016	8.3 9.2 7.6	17.7 17.0 16.4	2.0 -0.1	004	10.7 11.7 10.5	19.5 18.6 18.1	2.6 -0.2 2.8 ---	012 012	10.2 10.2 9.8	11.7 11.5 11.5
4/27 1230	48.7	.40	2.0	0.9	2.2	000	9.5	17.6 25.8 23.6	2.0 0.1	016	10.2 10.6 10.4	17.3 17.1 16.8	1.7 0.0	030	8.8 9.8 8.1	18.7 18.0 17.5	1.8 0.0	012	11.5 12.6 11.2	20.5 19.8 19.2	2.2 0.0 2.4 ---	019 016	10.3 10.3 9.9	11.9 11.8 11.8

4/27 1300	48.4	.39	1.8	0.7	2.2	022	9.6	18.1 26.3 25.1	2.2 0.1	028	10.4 10.7 11.0	18.0 17.7 17.4	2.1 0.0	039	8.8 9.8 8.2	18.9 18.3 17.7	1.9 0.0	024	10.9 12.2 11.2	20.0 19.6 19.4	2.5 -0.2 2.6	026	10.5 10.5 10.2	12.2 12.1 12.1
4/27 1330	48.2	.19	1.8	0.8	1.8	065	10.0	19.0 27.2 25.9	2.6 0.0	059	9.9 10.8 11.5	19.0 18.7 18.4	2.6 0.0	059	9.6 10.6 8.7	20.2 19.4 18.6	2.6 0.0	054	12.1 13.4 12.1	20.8 20.8 20.5	3.2 -0.3 3.3	062	10.8 10.8 10.3	12.4 12.3 12.3
4/27 1400	47.8	.06	2.1	0.9	2.2	054	10.4	19.8 27.9 26.6	2.3 0.0	040	10.2 11.2 12.1	19.7 19.5 19.2	2.3 0.0	063	10.0 11.1 9.2	21.0 20.2 19.6	2.1 0.0	050	13.0 14.2 12.8	22.1 21.9 21.5	2.9 -0.4 3.1	065	11.1 11.1 10.7	12.7 12.7 12.7
4/27 1430	47.6	.06	1.5	0.7	1.8	000	10.7	20.3 27.9 26.9	1.8 0.1	035	11.2 12.0 12.7	20.3 20.1 19.8	1.7 0.0	047	10.2 11.4 9.5	21.3 20.7 20.1	1.6 0.0	026	13.2 14.4 13.0	23.1 22.5 22.0	2.1 -0.2 2.2	045	11.3 11.3 10.8	13.0 12.8 12.8
4/27 1500	47.4	.11	1.3	0.5	1.8	054	10.8	20.6 28.0 27.0	2.1 0.1	033	11.0 11.9 12.7	20.6 20.3 20.0	2.1 0.0	046	10.1 11.4 9.4	21.4 20.7 20.2	1.8 0.0	036	11.8 13.1 11.5	21.3 20.9 20.5	2.2 -0.2 2.3	043	11.3 11.4 10.8	13.1 12.9 13.0
4/27 1530	46.8	.10	1.2	0.4	2.7	000	10.7	20.8 27.8 27.1	3.0 0.1	005	11.9 12.4 12.8	20.8 20.5 20.2	2.5 -0.1	018	10.0 11.3 9.4	21.4 20.8 20.3	2.5 -0.1	007	11.1 12.8 11.2	21.5 21.0 20.4	3.1 -0.1 3.3	011	11.3 11.4 10.8	13.0 12.9 13.0
4/27 1600	46.7	.26	1.1	0.4	2.7	000	10.6	20.7 21.0 18.8	3.4 0.1	007	11.7 12.2 12.7	20.8 20.5 20.2	2.8 -0.1	018	10.0 11.3 9.4	21.3 20.8 20.1	2.9 -0.1	013	11.0 12.7 11.1	21.3 20.9 20.3	3.2 0.0 3.6	012	11.3 11.4 10.8	13.0 12.9 13.0
4/27 1630	46.2	.24	1.0	0.3	2.7	018	10.5	20.6 19.4 17.2	3.2 0.1	022	11.4 12.0 12.6	20.7 20.5 20.2	2.9 -0.1	030	9.9 11.1 9.3	21.1 20.5 20.1	2.8 -0.1	024	10.9 12.6 11.1	21.1 20.8 20.3	3.4 0.1 3.7	020	11.3 11.3 10.6	13.0 12.8 13.0

4/27 1700	46.1	.27	0.7	0.2	2.7	0.0	10.5	20.6 19.7 17.6	3.1 005 0.2	11.8 20.8 12.4 20.5 12.8 20.2	2.5 018 -0.1	9.8 21.1 11.2 20.7 9.3 20.3	2.5 008 -0.1	10.8 21.1 12.5 20.7 11.0 20.2	3.4 005 0.1 3.8 002	11.3 13.0 11.3 12.8 10.8 13.0
4/27 1730	45.4	.28	0.4	0.0	2.2	0.0	10.2	20.2 18.2 16.1	2.7 008 0.1	11.6 20.4 12.2 20.2 12.6 20.0	2.3 022 -0.1	9.4 20.2 10.7 20.0 9.0 19.8	2.3 008 -0.1	10.3 20.3 12.1 20.1 10.6 19.8	2.8 011 0.0 3.2 009	11.1 12.8 11.2 12.8 10.7 12.8
4/27 1800	44.8	.27	0.2	-0.1	2.2	0.0	10.1	20.0 17.5 15.4	2.6 002 0.2	11.7 20.4 12.2 20.2 12.6 19.9	2.0 016 -0.1	9.1 19.8 10.5 19.7 8.9 19.6	2.2 000 -0.1	10.0 19.9 11.9 19.8 10.5 19.5	2.9 002 0.0 3.3 000	11.1 12.7 11.2 12.7 10.7 12.8
4/27 1830	44.1	.25	0.1	-0.2	2.2	0.18	9.8	19.6 15.8 13.6	2.2 014 0.1	11.0 19.8 11.7 19.7 12.2 19.5	1.9 028 -0.1	8.7 19.1 10.1 19.1 8.6 19.1	1.9 015 0.0	9.6 19.2 11.5 19.3 10.2 19.1	2.4 015 0.0 2.8 011	10.9 12.6 11.1 12.6 10.5 12.7
4/27 1900	43.8	.23	0.0	-0.2	2.2	0.18	9.7	19.1 15.4 13.3	2.2 008 0.1	11.1 19.4 11.6 19.3 12.0 19.1	1.8 025 -0.1	8.4 18.5 9.8 18.5 8.4 18.6	1.6 008 0.0	9.4 18.6 11.2 18.7 9.9 18.6	2.3 009 0.0 2.8 007	10.7 12.4 10.8 12.4 10.3 12.5
4/27 1930	43.2	.20	0.0	-0.2	2.2	0.00	8.9	17.9 14.6 12.3	2.3 001 0.1	11.0 18.5 11.3 18.3 11.5 18.0	1.8 019 -0.1	7.8 17.2 9.1 17.3 7.9 17.5	1.8 001 -0.1	8.7 17.4 10.4 17.5 9.3 17.4	3.1 003 0.0 3.8 002	10.4 12.0 10.6 12.1 10.1 12.2
4/27 2000	42.8	.21	0.0	-0.3	1.8	353	8.4	16.8 13.7 11.4	2.3 349 0.2	10.5 17.4 10.8 17.2 11.0 17.0	1.5 007 0.0	7.2 16.0 8.4 16.1 7.3 16.3	1.8 349 -0.1	8.0 16.2 19.7 16.4 8.6 16.2	3.2 351 0.2 4.0 350	10.2 11.7 10.2 11.7 9.8 11.7
4/27 2030	42.4	.21	0.0	-0.3	1.8	342	8.0	16.0 12.6 10.2	2.3 341 0.2	10.1 16.8 10.3 16.5 10.4 16.3	1.3 000 0.0	6.8 15.2 8.0 15.3 6.9 15.5	1.8 341 -0.1	7.6 15.4 9.3 15.6 8.2 15.5	3.1 341 0.1 4.1 343	9.0 10.6 9.2 10.6 8.7 10.8

4/27 2100	42.0	.20	0.0	-0.2	1.3	342	8.0	15.1 10.9 8.0	0.5 0.1	014	8.3 9.0 9.6	15.0 15.0 15.1	0.7 0.0	079	6.6 7.6 6.6	14.2 14.2 14.4	0.3 0.1	022	8.5 9.6 8.4	14.8 14.9 14.7	0.6 0.0 1.1	027 023	9.3 9.4 9.0	10.6 10.6 10.8
4/27 2130	41.7	.24	0.0	-0.2	0.4	V	8.1	14.0 8.8 5.5	0.2 0.0	234	6.5 7.4 8.1	12.8 13.0 13.2	0.5 0.0	094	6.0 7.1 6.7	12.5 12.7 13.3	0.3 0.1	232	7.7 8.9 8.2	13.2 13.5 13.6	0.7 0.0 0.9	170 136	8.9 9.1 8.7	10.1 10.2 10.5
4/27 2200	41.4	.20	0.0	-0.2	0.4	295	6.8	13.3 9.0 ----	1.0 0.0	287	7.3 7.8 8.2	12.8 12.9 13.1	0.7 0.0	308	5.9 7.1 6.2	12.0 12.2 13.2	1.3 0.0	289	5.5 7.0 6.9	11.1 11.7 12.8	1.4 0.0 0.7	276 262	8.5 9.0 8.7	9.7 10.2 10.4
4/27 2230	40.9	.24	0.0	-0.2	0.9	281	6.8	12.8 8.4 ----	0.8 0.0	267	6.7 7.3 7.6	12.5 12.5 12.5	1.0 0.1	255	8.1 8.4 6.5	13.3 13.1 12.9	1.1 0.0	271	5.8 7.1 6.4	11.6 11.9 12.1	2.0 0.0 2.2	255 241	8.6 8.9 8.6	9.8 10.0 10.3
4/27 2300	40.6	.23	0.0	-0.2	0.4	288	7.0	13.2 9.7 6.4	0.8 0.1	311	7.3 7.9 8.2	13.0 13.0 13.1	0.5 0.1	306	6.4 7.2 5.9	12.5 12.5 12.8	1.0 0.0	303	5.9 7.3 6.5	12.0 12.3 12.5	1.4 0.0 1.4	291 274	8.7 8.9 8.6	9.9 10.1 10.3
4/27 2330	40.0	.21	0.0	-0.2	0.9	281	7.6	14.7 9.2 6.1	0.8 0.1	278	7.8 8.5 9.0	14.4 14.5 14.5	0.8 0.1	265	8.1 8.8 7.1	14.8 14.7 14.7	1.1 0.0	277	6.9 8.3 7.5	13.5 13.8 14.0	1.7 0.0 2.0	269 262	9.2 9.4 9.0	10.6 10.7 10.9
4/28 0000	39.5	.19	0.0	-0.2	0.4	V	7.1	13.3 8.0 ----	0.8 0.1	298	7.3 7.9 8.2	13.1 13.1 13.2	0.4 0.1	280	7.2 8.0 6.6	13.2 13.2 13.3	0.9 0.0	290	6.3 7.6 6.8	12.3 12.6 12.7	1.3 0.0 1.3	279 264	8.8 8.9 8.6	10.0 10.1 10.4
4/28 0030	39.6	.16	0.0	-0.2	0.4	V	7.0	12.4 7.5 ----	0.3 0.1	296	6.8 7.5 7.9	11.9 12.0 12.1	0.2 0.0	332	6.3 7.3 6.2	11.7 11.9 12.1	0.6 0.0	299	5.5 6.8 6.2	10.7 11.2 11.5	1.0 0.0 1.4	225 221	8.3 8.5 8.2	9.4 9.5 9.7

4/28 0100	39.2	.21	0.0	-0.2	0.4	V	6.7	12.2 8.2 ---	0.4 0.0	039	6.2 6.9 7.5	11.3 11.5 11.9	0.5 0.0	059	5.5 6.5 5.7	11.0 11.2 11.8	0.4 0.0	006	6.1 7.2 6.7	10.9 11.4 11.8	0.5 0.0 0.7	091 106	8.4 8.5 8.2	9.5 9.6 9.7
4/28 0130	38.8	.23	0.0	-0.2	0.9	V	6.5	12.4 7.5 ----	0.4 0.0	268	6.3 7.1 7.6	11.8 12.0 12.2	0.3 0.1	228	6.7 7.4 6.0	12.2 12.1 12.2	0.7 0.0	272	6.3 7.4 6.6	11.5 11.7 11.8	1.0 0.0 1.1	244 228	8.4 8.6 8.3	9.6 9.7 10.0
4/28 0200	38.5	.17	0.0	-0.2	0.4	V	6.0	11.6 7.0 ---	0.7 0.1	293	6.6 7.1 7.4	11.7 11.7 11.8	0.3 0.1	273	6.0 6.6 5.4	11.3 11.2 11.4	0.9 0.0	288	5.5 6.6 5.9	10.7 10.9 11.1	1.3 0.0 1.4	272 263	8.3 8.5 8.3	9.4 9.6 9.9
4/28 0230	38.2	.22	0.0	-0.2	0.9	V	5.8	11.1 6.1 ----	0.7 0.0	282	6.1 6.6 6.9	10.8 10.9 11.1	0.4 0.1	269	5.7 6.4 5.2	10.6 10.6 10.9	0.9 0.0	282	4.7 6.0 5.6	9.5 10.1 10.5	1.2 0.0 1.3	267 254	8.0 8.3 8.1	9.1 9.3 9.6
4/28 0300	37.9	.22	0.0	-0.2	0.9	V	4.9	9.8 5.5 ----	1.0 0.1	276	5.4 5.8 6.0	9.7 9.7 9.8	0.9 0.1	271	5.4 5.8 4.6	9.9 9.7 9.9	1.1 0.0	280	4.4 5.4 4.8	8.8 9.0 9.1	2.3 0.0 2.5	271 264	7.6 7.9 7.8	8.6 8.9 9.3
4/28 0330	37.4	.22	0.0	-0.2	0.9	V	5.2	10.4 5.6 ----	0.8 0.1	284	5.7 6.2 6.3	10.1 10.2 10.2	0.7 0.1	284	5.4 6.0 4.9	10.2 10.2 10.5	1.0 0.0	288	4.6 5.7 5.1	9.3 9.6 9.8	1.9 0.0 2.1	267 254	7.8 8.0 7.8	8.7 9.0 9.3
4/28 0400	37.2	.22	0.0	-0.2	0.4	V	5.4	9.3 ---- ----	0.3 0.0	214	4.1 4.8 5.3	8.2 8.4 8.7	0.4 0.1	180	5.5 6.0 4.9	9.2 9.2 9.2	0.6 0.1	243	4.7 5.6 5.1	8.3 8.7 8.9	0.9 0.0 0.9	215 215	7.3 7.5 7.2	8.1 8.2 8.4
4/28 0430	36.7	.17	0.0	-0.2	0.9	V	5.1	10.0 ---- ----	0.9 0.1	296	6.1 6.4 6.5	10.0 10.0 10.1	0.6 0.1	316	4.3 5.3 4.5	9.0 9.3 9.8	1.0 0.0	297	3.9 5.1 4.8	8.3 8.8 9.4	1.2 0.0 1.2	289 280	7.4 7.7 7.4	8.3 8.6 8.8

4/28 0500	36.7	.28	0.0	-0.2	0.9	V	5.6	10.1 5.4 ----	0.6 0.0	219	5.4 5.9 6.2	9.7 9.8 9.9	0.6 0.1	187	5.4 5.9 4.9	9.7 9.8 9.9	0.6 0.0	239	5.2 6.2 5.5	9.1 9.6 9.7	1.5 0.0 1.9	210 206	7.5 7.7 7.5	8.4 8.5 8.8
4/28 0530	36.4	.28	0.0	-0.2	0.4	V	4.8	9.6 6.5 ----	1.4 0.1	312	5.9 6.1 6.0	9.9 9.8 9.7	0.9 0.0	324	4.4 5.1 4.1	9.2 9.2 9.3	1.2 0.0	309	4.7 5.6 5.0	9.0 9.2 9.1	1.9 0.0 2.2	310 304	7.5 7.6 7.6	8.4 8.5 9.0
4/28 0600	35.9	.30	0.0	-0.2	0.0	V	6.0	10.3 ---- ----	0.2 0.0	074	4.7 5.4 5.9	9.0 9.3 9.6	0.6 0.0	069	3.9 4.8 4.2	8.7 9.0 9.4	0.3 0.0	009	4.9 5.9 5.4	9.1 9.5 9.6	0.1 0.0 0.3	123 121	7.4 7.5 7.3	8.3 8.4 8.5
4/28 0630	35.5	.27	0.1	-0.2	0.4	230	5.7	10.6 ---- ----	0.6 0.0	245	5.2 5.9 6.3	10.0 10.1 10.3	0.7 0.2	237	6.6 7.1 5.7	11.1 11.0 10.8	0.8 0.0	253	5.2 6.2 5.5	9.6 9.9 10.0	1.4 0.0 1.5	257 268	7.8 7.9 7.7	8.8 8.9 9.1
4/28 0700	35.3	.27	0.1	-0.1	0.4	V	6.0	10.7 ---- ----	0.7 0.0	201	4.9 5.8 6.2	9.9 10.0 10.2	0.9 0.2	181	6.7 7.1 5.9	11.1 10.9 10.8	0.7 0.0	221	5.9 6.7 5.8	10.1 10.2 10.1	1.0 0.0 0.7	217 229	7.8 7.9 7.7	8.7 8.8 9.1
4/28 0730	35.3	.24	0.3	-0.1	0.4	V	6.6	11.6 6.8 ----	0.4 0.0	135	5.3 6.2 6.7	10.6 10.7 10.9	0.7 0.1	130	6.1 6.8 5.7	11.4 11.2 11.2	0.3 0.1	169	6.6 7.5 6.6	11.2 11.3 11.1	0.4 0.0 0.6	150 118	8.1 8.1 7.8	9.1 9.1 9.2
4/28 0800	35.1	.24	0.3	0.0	0.9	V	6.9	12.6 8.5 5.8	0.6 0.0	097	6.0 6.8 7.3	11.4 11.5 11.5	0.8 0.1	100	6.2 7.0 5.9	11.9 11.6 11.7	0.4 0.1	095	6.9 7.8 6.9	11.8 11.9 11.7	0.4 0.0 0.4	149 142	8.4 8.4 8.1	9.4 9.4 9.4
4/28 0830	34.9	.26	0.4	0.0	1.8	043	7.1	13.4 ---- ----	0.6 0.0	036	6.5 7.3 7.7	12.1 12.2 12.2	0.8 0.0	069	6.3 7.3 6.1	12.5 12.3 12.2	0.5 0.0	031	7.2 8.1 7.2	12.4 12.5 12.2	1.2 0.0 1.3	009 009	8.6 8.7 8.3	9.7 9.7 9.7

4/28 0900	34.6	.24	0.6	0.1	1.3	000	7.2	13.8	2.1	018	7.6	13.7	1.9	029	6.6	13.9	1.8	016	7.4	13.8	2.2	023	8.8	10.1
							10.5	0.1			8.2	13.6	0.0		7.9	13.6	0.0		8.6	13.7	0.0		8.9	10.0
							8.1				8.4	13.5			6.3	13.4			7.5	13.4		2.4	019	8.5
4/28 0930	34.4	.28	1.2	0.4	1.3	079	8.2	15.1	1.7	075	7.7	14.8	1.8	078	7.9	15.7	1.6	071	9.2	15.5	2.1	078	9.5	10.8
							12.9	0.0			8.6	14.7	0.0		8.9	15.3	0.1		10.1	15.3	-0.1		9.6	10.7
							10.3				9.1	14.6			7.4	14.9			8.9	15.0	2.2	076	9.1	10.8
4/28 1000	34.2	.29	1.6	0.6	1.3	090	9.1	16.8	1.8	089	8.6	16.6	1.9	087	9.5	17.8	1.7	083	10.3	17.1	2.1	087	10.2	11.6
							14.0	0.0			9.6	16.6	0.0		10.1	17.3	0.1		11.2	16.9	-0.1		10.2	11.5
							11.5				10.3	16.3			8.4	16.8			9.9	16.7	2.3	085	9.7	11.5
4/28 1030	34.0	.29	1.8	0.8	1.3	072	10.0	17.8	1.1	084	9.5	17.8	1.4	086	10.6	18.8	1.0	081	10.9	18.3	1.4	079	10.6	12.1
							14.2	0.0			10.6	17.7	0.0		11.1	18.3	0.1		11.9	18.0	-0.1		10.6	11.0
							11.8				11.2	17.5			9.3	17.9			10.7	17.8	1.5	079	10.2	12.1
4/28 1100	33.9	.31	1.8	0.8	1.3	072	10.5	19.2	1.6	068	10.2	19.1	1.7	077	11.2	20.4	1.4	073	11.7	19.7	1.9	073	11.0	12.6
							15.5	0.0			11.4	19.0	0.0		11.8	19.8	0.1		12.7	19.4	-0.1		11.0	12.5
							13.4				11.9	18.8			9.8	19.4			11.4	19.2	1.9	072	10.5	12.5
4/28 1130	34.1	.28	2.0	0.9	1.8	086	11.3	21.0	2.3	082	10.6	20.9	2.3	082	11.7	22.2	2.2	080	12.4	21.2	2.8	079	11.5	13.2
							16.7	-0.1			12.0	20.7	0.0		12.5	21.5	0.1		13.5	21.0	-0.1		11.5	13.1
							14.6				12.8	20.4			10.4	20.9			12.2	20.9	2.9	078	10.9	13.1
4/28 1200	34.0	.29	1.5	0.7	1.3	083	11.2	21.3	1.3	072	10.6	21.2	1.5	085	11.5	22.2	1.3	078	12.2	21.5	1.4	079	11.9	13.4
							16.4	0.0			12.2	21.1	0.0		12.5	21.7	0.1		13.6	21.4	-0.1		11.6	13.3
							14.6				13.0	21.0			10.3	21.3			12.2	21.3	1.5	081	11.1	13.3
4/28 1230	33.7	.28	1.2	0.5	1.3	V	11.2	21.6	0.8	141	10.8	21.9	1.2	141	12.0	22.4	0.7	176	12.1	22.1	1.3	176	11.5	13.3
							15.3	0.0			12.5	21.8	0.1		12.8	22.0	0.1		13.8	22.0	0.0		11.5	13.2
							13.6				13.3	21.6			11.1	21.7			12.3	21.7	1.5	170	11.0	13.3

4/28 1300	33.5	.30	1.1	0.4	1.8	173	11.3	21.8 13.1 13.0	2.3 0.0	174	11.0 12.6 13.4	22.4 22.2 21.9	2.7 0.3	170	12.6 13.2 11.3	22.6 22.2 21.9	2.2 0.2	182	12.5 14.1 12.4	22.3 22.2 21.9	3.1 -0.2 3.4	177 174	11.5 11.6 11.0	13.3 13.3 13.3
4/28 1330	33.4	.26	1.3	0.7	2.7	108	11.7	22.3 16.3 14.7	1.4 0.0	107	11.4 13.0 13.7	22.5 22.3 22.1	1.6 0.1	108	12.3 13.2 11.4	23.1 22.6 22.2	1.2 0.1	107	12.8 14.3 12.8	22.7 22.5 22.2	1.5 -0.1 1.5	098 102	11.7 11.7 11.1	13.5 13.4 13.4
4/28 1400	33.4	.28	1.4	0.7	1.3	180	11.8	22.1 15.8 14.0	1.9 0.0	159	11.6 13.2 14.0	22.9 22.7 22.5	2.1 0.2	155	13.0 13.7 11.8	23.2 22.7 22.4	1.4 0.2	165	13.2 14.6 13.0	22.9 22.7 22.4	2.5 -0.2 2.7	163 159	11.8 11.8 11.2	13.6 13.5 13.5
4/28 1430	---	---	0.7	---	1.8	V	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2.0 -0.1 2.2	048 050	11.6 11.6 11.1	13.4 13.3 13.3
4/28 1500	---	---	0.5	---	3.1	000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.7 0.0 4.1	024 020	11.4 11.4 10.9	13.1 13.0 13.0
4/28 1530	---	---	1.0	---	3.1	072	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.3 -0.2 3.6	073 073	11.5 11.6 11.0	13.3 13.2 13.2
4/28 1600	---	---	1.4	---	2.7	090	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2.7 -0.1 2.9	069 070	11.8 11.8 11.2	13.5 13.5 13.5
4/28 1630	---	---	0.6	---	2.2	054	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.8 -0.2 1.9	058 057	11.6 11.7 11.1	13.4 13.3 13.3

4/28 2100	30.3	.25	0.0	-0.2	0.4	V	6.5	11.5	0.6	223	5.9	10.8	0.8	216	7.3	11.9	1.0	248	6.5	10.8	1.3	219	8.6	9.6
								---	0.0		6.7	10.9	0.1		7.5	11.6	0.0		7.4	11.2	0.0		8.8	9.8
								---			7.1	11.3			6.2	11.5			6.8	11.5	1.2	214	8.5	10.1
4/28 2130	30.0	.25	0.0	-0.2	0.9	290	5.4	10.4	1.1	297	6.2	10.3	1.1	310	5.0	9.9	1.5	300	4.8	9.1	2.3	279	8.1	9.1
								---	0.1		6.5	10.3	0.0		5.7	10.0	0.0		5.7	9.4	0.0		8.6	9.7
								---			6.5	10.5			5.6	11.5			5.5	10.1	2.1	265	8.4	10.0
4/28 2200	29.8	.23	0.0	-0.2	0.9	290	5.1	9.8	0.7	298	5.5	9.5	0.5	321	4.6	9.0	1.2	302	4.3	8.3	1.1	280	7.6	8.5
								---	0.1		6.0	9.5	0.0		5.2	9.0	0.0		5.2	8.6	0.0		7.9	8.8
								---			6.0	9.6			4.7	9.7			5.1	9.4	1.0	273	7.8	9.2
4/28 2230	29.5	.23	0.0	-0.2	0.4	260	4.8	8.9	0.7	267	5.0	8.6	1.1	257	5.8	9.5	1.4	270	4.1	7.8	2.0	256	7.6	8.5
								---	0.0		5.3	8.6	0.1		5.8	9.2	0.0		5.0	8.3	0.0		7.8	8.6
								---			5.6	9.0			4.5	9.1			4.7	8.8	2.4	242	7.7	9.0
4/28 2300	29.5	.22	0.0	-0.2	0.4	234	4.8	8.6	0.6	199	4.0	6.9	0.8	190	5.6	9.1	0.6	229	4.0	7.2	1.3	215	7.3	8.0
								---	0.0		4.2	7.1	0.1		5.8	8.9	0.0		4.7	7.6	0.0		7.5	8.3
								---			4.7	7.7			5.0	8.9			4.3	7.8	1.6	227	7.4	8.6
4/28 2330	29.4	.18	0.0	-0.2	0.4	216	4.0	6.9	0.8	220	3.3	5.7	1.2	213	5.1	7.7	1.1	247	3.3	5.8	2.2	214	7.0	7.6
								---	0.0		3.4	5.6	0.1		4.9	7.3	0.0		3.9	6.2	0.0		7.2	7.9
								---			3.8	6.2			3.8	7.3			3.7	6.5	2.6	206	7.0	8.2
4/29 0000	29.3	.19	0.0	-0.2	0.4	234	3.7	7.3	0.7	266	3.7	6.2	1.1	255	4.7	7.9	1.4	269	3.1	6.2	2.0	253	6.9	7.6
								---	0.0		3.6	5.9	0.1		4.7	7.6	0.0		3.9	6.7	0.0		7.0	7.7
								---			3.7	6.1			3.6	7.6			3.7	7.1	2.4	239	6.9	8.0
4/29 0030	29.1	.19	0.0	-0.2	0.4	220	3.6	7.6	1.3	194	3.0	6.1	1.8	185	5.0	8.1	1.2	202	4.1	7.0	2.3	225	6.9	7.6
								---	0.0		3.4	6.2	0.2		4.9	7.7	0.0		4.6	7.1	0.0		7.0	7.7
								---			3.8	6.7			3.8	7.5			3.8	6.9	2.9	236	6.8	7.9

4/29 0100	28.2	.22	0.0	-0.2	0.4	228	4.0	7.5	0.7	233	2.9	5.2	1.0	226	5.1	8.0	1.1	248	3.4	6.4	2.0	230	6.8	7.5
									0.0		3.1	5.4	0.2		5.2	7.8	0.0		4.1	6.7	0.0	6.9	7.6	
											3.5	6.1		4.2	7.6			3.7	6.9	2.5	221	6.8	7.8	
4/29 0130	28.2	.22	0.0	-0.2	0.4	241	3.9	7.3	1.2	228	3.1	5.5	1.5	227	5.0	8.0	1.3	237	3.6	6.6	2.9	240	6.8	7.5
									0.0		3.3	5.7	0.2		4.9	7.6	0.0		4.2	6.8	0.0	6.9	7.6	
											3.7	6.3		3.8	7.4			3.7	6.8	3.6	231	6.7	7.8	
4/29 0200	28.3	.23	0.0	-0.2	1.3	241	3.8	7.3	1.8	230	3.4	6.1	2.6	236	5.4	8.3	2.0	239	3.7	6.8	3.5	239	6.8	7.4
									0.0		3.6	6.3	0.4		5.0	7.8	-0.1		4.3	7.0	0.0	6.8	7.5	
											4.0	6.7		3.8	7.4			3.8	7.0	4.3	233	6.7	7.7	
4/29 0230	27.9	.26	0.0	-0.2	1.3	245	3.4	6.9	1.4	245	3.2	5.6	2.4	249	5.0	7.8	2.2	254	3.4	6.3	3.3	252	6.7	7.4
									0.0		3.3	5.8	0.3		4.7	7.3	-0.1		4.0	6.6	0.0	6.8	7.4	
											3.7	6.1		3.5	7.0			3.5	6.6	4.0	246	6.6	7.5	
4/29 0300	27.6	.25	0.0	-0.2	0.9	252	3.1	6.2	1.2	244	3.1	5.4	2.0	245	4.5	7.0	1.7	253	2.9	5.6	3.2	248	6.3	6.9
									0.0		3.2	5.4	0.3		4.1	6.5	0.0		3.5	5.8	0.0	6.4	6.9	
											3.3	5.6		3.0	6.3			3.0	5.8	3.8	240	6.2	7.1	
4/29 0330	27.3	.26	0.0	-0.2	0.9	234	2.7	5.5	1.3	228	2.3	4.4	1.6	229	4.0	6.2	1.3	239	2.5	4.8	3.1	239	5.9	6.5
									0.0		2.4	4.5	0.2		3.7	5.8	0.0		3.0	5.1	0.0	6.0	6.5	
											2.7	4.9		2.7	5.6			2.6	5.0	3.9	236	5.9	6.7	
4/29 0400	27.1	.23	0.0	-0.2	0.4	234	2.6	5.3	1.2	233	2.1	4.1	1.6	231	4.0	6.1	1.4	241	2.5	4.7	3.0	238	5.9	6.5
									0.0		2.3	4.2	0.2		3.7	5.7	0.0		3.0	5.0	0.0	6.0	6.5	
											2.5	4.6		2.6	5.4			2.5	4.9	3.7	232	5.9	6.7	
4/29 0430	27.0	.23	0.0	-0.2	0.4	248	2.3	4.8	1.0	253	2.2	3.9	1.6	253	3.5	5.5	1.6	241	2.0	4.1	2.7	248	5.8	6.3
									0.0		2.2	3.9	0.2		3.3	5.1	0.0		2.5	4.4	0.0	5.9	6.3	
											2.3	4.1		2.3	4.9			2.2	4.4	3.6	235	5.8	6.6	

4/29 0500	26.8	.22	0.0	-0.2	0.9	243	2.1	4.8	1.2	248	2.2	3.9	2.0	237	3.7	5.7	1.6	246	2.1	4.2	3.5	244	5.7	6.2
								---	0.0		2.2	3.9	0.3		3.2	5.2	0.0		2.5	4.4	0.0		5.8	6.2
								---			2.3	4.2			2.2	4.8			2.1	4.4	4.0	238	5.6	6.4
4/29 0530	26.4	.23	0.0	-0.2	0.4	240	1.9	4.3	1.0	235	1.6	3.1	1.5	233	3.1	5.0	1.2	241	1.8	3.7	3.1	240	5.4	5.9
								---	0.0		1.6	3.3	0.2		2.8	4.6	0.0		2.3	4.0	0.0		5.5	5.9
								---			1.8	3.6			1.9	4.4			1.9	3.9	3.8	231	5.4	6.2
4/29 0600	26.3	.23	0.0	-0.2	0.9	240	2.0	4.5	1.2	238	1.8	3.5	1.8	237	3.4	5.3	1.5	245	2.0	4.0	3.2	243	5.5	6.0
								---	0.0		1.8	3.5	0.3		3.0	4.9	0.0		2.4	4.2	0.0		5.6	6.0
								---			1.9	3.8			2.1	4.6			2.0	4.2	3.9	236	5.4	6.2
4/29 0630	26.0	.23	0.1	-0.1	0.9	234	3.1	6.0	1.7	224	3.7	6.2	2.2	219	4.9	7.2	1.9	219	3.7	6.1	3.1	234	5.7	6.3
								---	0.0		3.6	6.1	0.4		4.3	6.7	0.0		4.0	6.2	0.0		5.8	6.2
								---			3.6	6.1			3.3	6.3			3.3	5.9	3.7	227	5.6	6.4
4/29 0700	26.1	.23	0.2	-0.1	1.3	225	4.1	7.7	2.0	216	4.8	8.1	2.6	219	5.9	8.8	2.2	217	4.9	7.9	3.4	224	6.8	7.5
								---	0.0		4.9	8.0	0.4		5.5	8.4	0.0		5.3	8.0	-0.1		6.9	7.5
								---			4.9	7.9			4.4	7.9			4.5	7.7	3.9	219	6.6	7.5
4/29 0730	26.1	.24	0.5	0.1	1.3	238	6.3	11.1	1.8	232	7.6	12.0	2.4	235	7.7	12.0	1.8	239	7.1	11.5	3.0	243	8.3	9.2
								---	0.0		7.7	11.9	0.4		7.6	11.7	0.0		7.7	11.6	0.0		8.3	9.1
								---			7.7	11.8			6.4	11.3			6.9	11.4	3.2	239	8.0	9.1
4/29 0800	25.9	.25	0.7	0.2	1.3	234	7.9	13.8	1.5	231	9.7	15.3	2.2	234	9.2	14.7	1.8	238	9.0	14.5	2.7	242	9.2	10.3
								---	0.0		10.0	15.2	0.3		9.3	14.4	0.0		9.6	14.5	0.0		9.2	10.2
								---			9.9	14.9			8.0	14.1			8.6	14.2	2.8	238	8.8	10.2
4/29 0830	25.8	.25	0.8	0.2	1.3	216	9.7	16.4	1.3	190	11.1	17.7	1.5	185	10.7	17.3	1.3	192	11.1	17.1	1.9	200	10.2	11.5
								---	0.0		11.6	17.8	0.2		11.0	17.0	0.1		11.6	17.1	-0.1		10.3	11.4
								---			11.7	17.4			9.7	16.8			10.4	16.7	2.2	192	9.9	11.4

4/29 0900	25.6	.29	1.1	0.4	3.1	144	11.6	19.0	4.4	143	12.8	20.4	4.0	136	12.2	19.8	3.7	138	13.9	19.8	5.2	145	11.3	12.6
								---	-0.1		12.9	20.0	0.2		12.9	19.5	0.4		13.9	19.6	-0.3		11.3	12.4
								---			13.4	19.7			11.5	19.2			12.6	19.3	5.7	143	10.8	12.4

4/29 0930	25.6	.43	1.3	0.6	4.5	135	12.1	20.0	5.2	137	13.1	21.5	4.8	127	12.7	20.9	4.4	129	14.3	20.8	6.4	129	11.5	12.9
								---	-0.1		13.5	21.0	0.2		13.6	20.7	0.5		14.5	20.6	-0.4		11.5	12.7
								---			14.1	20.7			12.0	20.1			13.1	20.2	7.2	128	11.0	12.7

4/29 1000	25.5	.43	1.5	0.7	5.8	130	12.5	20.7	6.4	130	13.2	22.0	5.9	120	13.2	21.9	5.6	122	14.7	21.4	7.6	126	11.7	13.1
								---	-0.1		13.9	21.6	0.2		14.3	21.9	0.6		14.8	21.2	-0.5		11.7	13.0
								---			14.6	21.5			12.4	20.9			13.4	20.9	8.6	123	11.1	12.9

UNITED STATES
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