Contact Hours: A New Metric for Monitoring Child Injuries and Illnesses in Child Care Centers

Richard Fiene PhD

November 2023

This paper will introduce a new metric called "Contact Hours" which is being proposed as a potential statistical methodology for monitoring child injuries and illnesses in child care centers. The Contact Hour metric has been used in the past for measuring regulatory compliance with adult child ratios (see poster attachment #1) and for measuring COVID19 exposures (see paper attachments #2 & #3).

As described in the attachments, the Contact Hours metric is a simple straightforward mathematical model based upon asking 6 questions which essentially provide the data for constructing the area of a trapezoid and then using a series of algorithms and conversion tables to determine the area or density of contact between the adults and children while interacting in a specific space.

The Contact Hour metric was originally proposed in 1979 as an efficient and effective methodology determining regulatory compliance with the Federal Interagency Day Care Requirements (FIDCR) staff-child ratio and group size rules. It could be done without making on-site observations, which was a major selling point for the Federal government staff. Unfortunately, the Contact Hour metric never got a chance to be tested on a large scale because the FIDCR was rescinded in 1980 and the proposed monitoring system was never implemented.

The Contact Hour metric sat dormant for 40 years until the COVID19 pandemic occurred in 2020 and there was a need for doing virtual monitoring. Suddenly the metric became relevant again. It was pilot tested in the state of Washington and again worked very well as a mathematical model for determining potential exposure rates. However, it never got a chance to be tested on a large scale because thankfully the COVID19 pandemic subsided, and on-site inspections started up again.

But that brings us to today and the need to monitor child injury data and illness data as the two outcome variables in child care related to health and safety. It is being proposed that potentially the Contact Hour metric may be a methodology that could be used as a monitoring tool to determine potential risk levels. For example, the size of a child care center (number of children present) has been determined to be related to the number of injuries that occur at a particular facility. The larger the Washington study in utilizing the model in determining potential COVID19 exposure, could it also be used to determine the potential spread of infectious diseases.

The only way to determine if the Contact Hour metric and mathematical model is a proper methodology is to conduct a large-scale study to determine if it is capable of monitoring significant changes in the two outcome variables of child injury data and illness data. This study could be undertaken in a single state or in multiple states to determine the efficacy of the approach. Most states collect data on child injuries and illnesses, the task for this study would be matching those data with the six questions that need to be asked as part of the Contact Hour methodology. Once that is accomplished, results from the Conversion Table would be compared to the injury and illness data.

Appendices:

Attachment #1: Poster which describes how the Contact Hour metric was used back in 1979 to measure regulatory compliance with staff child ratios and group size.

Attachment #2: 2020 Paper which proposes how the Contact Hour metric could potentially be used to determine exposure to COVID19.

Attachment #3: Paper (Fiene & Stevens, 2021) describes the results from a study done in the state of Washington utilizing the Contact Hour metric and how the use of contact hours, which takes time into consideration, might be a better model for determining overall exposure time based upon density rather than point in time counting of adults and children.

Richard Fiene PhD, Research Psychologist & Regulatory Scientist, Research Institute for Key Indicators Data Laboratory, Penn State Prevention Research Center, RFiene@RIKInstitute.com

Theoretical Model For Computing Adult-Child Ratios in Day Care Centers

Dr. Richard Fiene

Dr. Richard Fiene here presents a theoretical model for computing adult-child ratios which takes both numbers (caregivers and children) and time (hours at the day care center) into account. Its purpose is to increase accuracy and save time in the computation of ratios to determine compliance with requirements, whether for FDCR or for licensing.

He is beginning an adaptation of this model for use in residential or twenty-four hour facilities.

He has confidence that his model can be put into State regulatory systems, using the expertise of program oriented licensers and statistics/research oriented technicians.

If you care to explore this presentation further, you may call Dr. Fiene at 717-787-2724. He is Director, Bureau of Information Systems, Pa.DPW, 1514 N. 2nd St., Harrisburg, Pa. 17102.

There has been much controversy over the Federal Day Care Requirements, in particular, the adult-child ratios. The majority of the discussion has revolved around the dichotomous points of view of the states and the federal role in enforcing the various standards. There is another issue that is equally important, which has been addressed only in a side-glance manner. Once it is decided what the ratios will be, how are we going to measure compliance with the ratios?

There have been various attempts at doing this - the most recent had been tried by Health, Education and Welfare (1977) and it does get at the required information. There is only one problem with it: it is rather time consuming. If a state or region has a great number of programs, it becomes almost an impossible task. Past methods have tried the direct approach of dividing the total number of children by the total number of teachers. This works, but does not give the overall day picture; therefore it is only good as a very gross measure.

The staff-child ratio question is a very critical item when it comes to monitoring of child development/child care facilities. However, it has eluded proper measurement because of inadequate or time-consuming measures. I am proposing a new theoretical model for computing adult-child ratios which is not time-consuming and gives accurate information in a very concise fashion.

With this new approach, all a day care monitor needs to do is ask six questions of the provider, and then put the data into a formula to find if the program is within compliance or not.

The six questions are as follows:

(1) When does your first staff member (teaching) arrive?

(2) When does your last staff member (teaching) leave?

(3) Number of teaching staff?

(4) Number of children present on your maximum enrollment day? Their ages and which staff members are assigned to each age group? (If there is vertical grouping).

(5) When does your last child arrive?

(6) When does your first child leave? (If vertical grouping, give breakdown according to age.)

After these questions are answered, then the day care monitor will compute the number of contact hours (CH) between staff and children using the following formula:

$$CH = \frac{NC(TH+TO)}{2} \qquad \text{Formula 1}$$

In the formula, NC = total number of children present on the maximum enrollment day. TO = total number of hours the center is open. TH = total number of hours at full enrollment. CH = contact hours between staff and children in any type of caring arrangement.

After the CH is computed, the data are then put into another formula which will determine the relatively weighted contact hours for horizontal grouping (RWCH), or the relatively weighted contact hours range (RWCHR) for a vertically grouped program.

$$RWCH = \left[\frac{NC(TH+TO)}{2}\right]\left[\frac{1}{TA}\right] \qquad \text{Formula 2}$$

$$RWCHR = \left[\frac{\sum NC_o(TH_o+TO_o)}{2}\right]\left[\sum\frac{1}{TA}\right] \qquad \text{Formula 3}$$

$$NC_o = NC_p + NC_i + NC_s \qquad \text{Formula 4}$$

$$TH_o = TH_p + TH_i + TH_s \qquad \text{Formula 5}$$

$$TO_o = TO_p + TO_i + TO_s \qquad \text{Formula 6}$$

In the formulae above, NC_o = total number of children on the maximum enrollment day. TO_o = total number of hours the center is open. TH_o = total number of hours at full enrollment. RWCH = relatively weighted contact hours — indicator of compliance for horizontally grouped programs. RWCHR = relatively weighted contact hours range — indicator of compliance for vertically grouped programs. TA = total number of teaching staff. NC_i = total number of infants. NC_p = total number of preschoolers. NC_s = total number of school age children. TH_p = total number of hours at full enrollment with preschoolers. TH_i = total number of hours at full enrollment with infants-toddlers. TH_s = total number of hours at full enrollment with school-age children. I = infant-toddlers. P = preschoolers. S = school-age children.

Once the RWCH or the RWCHR figures are computed, now we can find if the programs are within compliance by using the Table of Conversions for RWCH and RWCHR. (See Table 1).

This table is computed from an ideal where TO and TH both equal eight hours. In other words, all staff and children arrive and leave at the same time which is an ideal programmatic set-up. By using the Table of Conversions, it is relatively easy to compute if a program is within compliance.

I think a few examples will suffice:

Example A: Day care monitor asks the six questions and gets:

(1) 6:30 a.m.
(2) 5:30 p.m.
(3) six staff
(4) 35 children - all four years old
(5) 9:30 a.m.
(6) 3:15 p.m.

Compute CH:

$$CH = \frac{NC(TH+TO)}{2} = \frac{35(5.45+11)}{2} = \frac{35(16.45)}{2} = 287.87$$

Compute RWCH: (because it is a horizontally grouped program).

$$RWCH = \left[\frac{NC(TH+TO)}{2}\right]\left[\frac{1}{TA}\right] = \left[\frac{35(5.45+11)}{2}\right]\left[\frac{1}{6}\right] = \left[\frac{35(16.45)}{2}\right]\left[\frac{1}{6}\right] = \left[287.87\right]\left[\frac{1}{6}\right] = 47.97$$

Now refer to the Table of Conversions. Look under NC = 35, CH = 280. Now look under RWCH in the P column. The score here is 56, which indicates that this program is well within compliance. In reading the Table of Conversions, if a program receives a score equal to or less than the score on the Table it will always be within compliance. If the program receives a score greater than the score on the Table for that particular category, then the program will always be out of compliance.

Example B: Day Care monitor asks the six questions and gets:

(1) 6:00 a.m.
(2) 6:00 p.m.
(3) three staff
(4) 15 children — five infants, five preschoolers, five school age children
(5) 10:00 a.m.
(6) 4:00 p.m.

Compute CH:

$$CH = \frac{NC(TH+TO)}{2} = \frac{15(6+12)}{2} = \frac{15(18)}{2} = 135$$

(Continued on page 11)

Appeared in the National Association for Regulatory Administration's News

April, 1980

Volume 1, Number 7, pps 9-11.

Theoretical Model For Computing Adult-Child Ratios In Day Care Centers

(Continued from page 9)

Compute RWCHR: (because it is a vertically grouped program).

$$RWCHR=\left[\frac{\sum NC_x\,(TH_x+TO_x)}{2}\right]\left[\sum\frac{1}{TA}\right]$$

$$RWCHR=\left[\frac{NC_c\,(TH_c+TO_c)\;+\;NC_p\,(TH_p+TO_p)\;+\;NC_s\,(TH_s+TO_s)}{2}\right]\left[\sum\frac{1}{TA}\right]$$

$$=\left[\frac{[5(6+12)]+[5(6+12)]+[5(6+12)]}{2}\right]\left[\frac{1}{3}\right]$$

$$=\left[\frac{90+90+90}{2}\right]\left[\frac{1}{3}\right]$$

$$=\left[135\right]\left[\frac{1}{3}\right]$$

$$=\ 45.00$$

Now refer to the Table of Conversions. Look under NC = 15, CH = 120. Now look under RWCHR in the P column because we have an equal number of infants, preschoolers and school age children. The score here is 40-50 which indicates this program is well within compliance.

Example C: Day care monitor asks the six questions and gets:

(1) 6:00 a.m.
(2) 6:00 p.m.
(3) Three staff
(4) 20 children — all four years old
(5) 7:00 a.m.
(6) 5:00 p.m.

Compute CH:

$$CH=\frac{NC\,(TH+TO)}{2}$$

$$=\frac{20\,(10+12)}{2}$$

$$=\frac{20\,(22)}{2}$$

$$=\frac{440}{2}$$

$$=\ 220$$

Compute RWCH: (because it is horizontally grouped program).

$$RWCH=\left[\frac{NC\,(TH+TO)}{2}\right]\left[\frac{1}{TA}\right]$$

$$=\left[\frac{20\,(10+12)}{2}\right]\left[\frac{1}{3}\right]$$

$$=\left[\frac{20\,(22)}{2}\right]\left[\frac{1}{3}\right]$$

$$=\left[\frac{440}{2}\right]\left[\frac{1}{3}\right]$$

$$=\left[220\right]\left[\frac{1}{3}\right]$$

$$=\ 73.33$$

Now refer to the Table of Conversions. Look under NC = 20, CH = 160. Now look under RWCH in the P column. The score here is 53, which indicates that this program is well out of compliance.

The aspect of the above theoretical model is that it takes both time and numbers of staff into account. It is a simple one-shot mathematical calculation, and it can determine if a program is within compliance or not.

Contact Hour Pilot Study Design Proposal
Richard Fiene, Ph.D.
Research Institute for Key Indicators
April 2020

The purpose of this proposal is to develop the key parameters for testing out the Contact Hour (CH) methodology in a series of facilities to determine its efficacy. The pilot will determine if this CH methodology has any merit in being able to be used as a rough estimate to identifying facilities that may be at greater risk to spreading an infectious disease, such as the COVID19 virus. Since monitoring of facilities will not be occurring during the COVID19 pandemic are there ways to measure the research question in the previous sentence. Yes there is and it is based upon the Contact Hour (CH) methodology and involves asking the following seven questions[1]:

1. **When does your first teaching staff arrive or when does your facility open?**
2. **When does your last teaching staff leave or when does your facility close?**
3. **Number of teaching/caregiving staff?**
3. **Number of children on your maximum enrollment day?**
5. **When does your last child arrive?**
6. **When does your first child leave?**
4. **Has any child or adult within your facility contracted the COVID19 virus?**

After getting the answers to these questions, the following formulae can be used to determine contact hours (CH) based upon the relationship between when the children arrive and leave (TH) and how long the facility is open (TO):

(1) CH=((NC(TO+TH))/2)/TA; (2) CH=(NCxTO)/TA; (3) CH=((NCxTO)/2)/TA; (4) CH=(NC$^{2)/TA}$

Where: CH = Contact Hours; NC = Number of Children; TO = Total number of hours the facility is open; TA = Total number of teaching staff, and TH = Total number of hours at full enrollment.

By knowing the number of contact hours (CH) it will be possible to rank order the exposure time of adults with children. This metric could then be used to determine if greater contact hours is correlated with the increased risk of the COVID19 virus. The COVID19 virus question is the dependent variable and is not used in the above formulae.

The following chart can be used by entering the following metrics (example in the table is based upon 5 enrolled children (NC)): the facility is open for 10 hours (TO) and then various scenarios are played out for how long the facility is at full enrollment (TH). Based upon these metrics an outcome rubric can be used where less CH is a positive (+), while high CH is a negative (-). For simplicity, the following chart is based upon one teaching staff (TA) being present (1:5 Adult-Child Ratio). The chart on page 2 provides a more detailed depiction of various CH for a multitude of Adult-Child Ratios and the figure on page 3 shows a hypothesized relationship between CH and COVID19 infection rates.

Contact Hour Score Generated from Above 4 Formulae and Potential Outcomes (COVID19 Infections)

Contact Hours - CH Score	Formulae for CH Score	Potential Outcomes
10	(2 (NC) x 10 (TO)) / 2	+ (None or few COVID19 Infections)
38	(5 (NC) (5 (TH) + 10 (TO)) / 2	+ / - (Lower # of COVID19 Infections)
80	8 (NC) x 10 (TO)	-/ + (Higher # of COVID19 Infections)
100	10 (NC) x 10 (TO)	-(Highest # of COVID19 Infections)

Contact Hour (CH) Conversion Table (Fiene, 2020©)

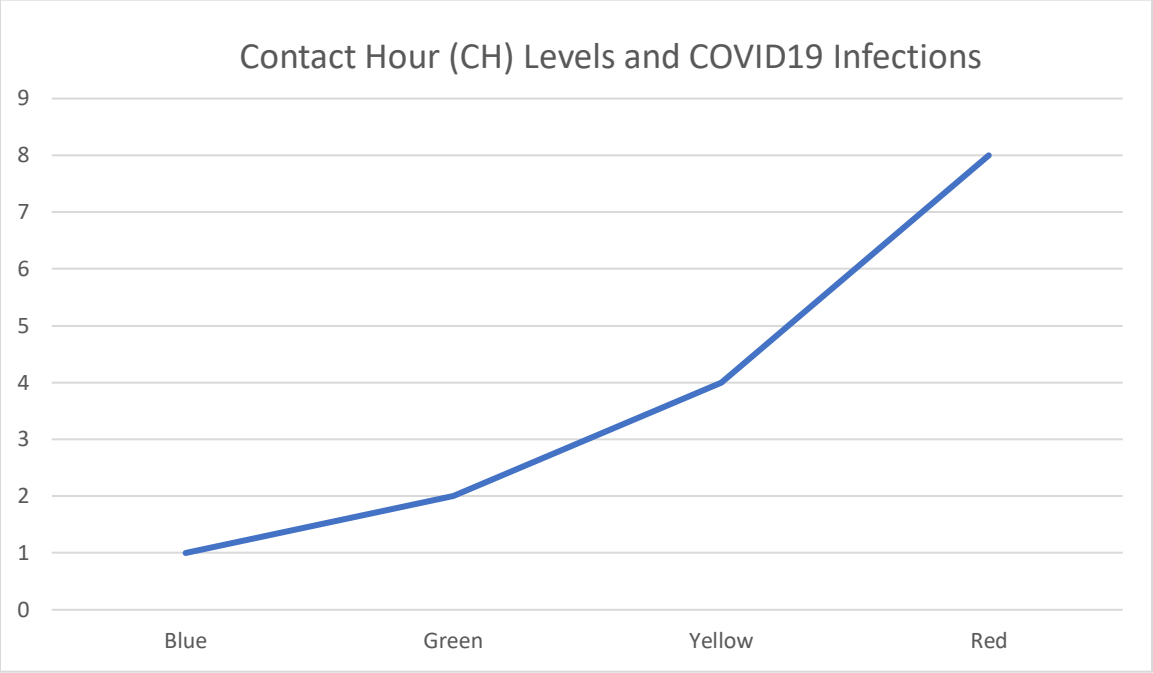
The previous chart on page 1 provided a theoretical view of how Contact Hours could be calculated, the following chart provides the addition of the number of staff (TA) in the equation and enhances the Contact Hours metric by calculating a Relatively Weighted Contact Hours (RWCH).

<---------- Adult-Child Ratios (Relatively Weighted Contact Hours) ---------->

NC	CH GS	1:1	2:1	3:1	4:1	5:1	6:1	7:1	8:1	9:1	10:1	11:1	12:1	13:1	14:1	15:1
1	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
2	20	10	20	20	20	20	20	20	20	20	20	20	20	20	20	20
3	30	10	15	30	30	30	30	30	30	30	30	30	30	30	30	30
4	40	10	20	20	40	40	40	40	40	40	40	40	40	40	40	40
5	50	10	17	25	25	50	50	50	50	50	50	50	50	50	50	50
6	60	10	20	30	30	30	60	60	60	60	60	60	60	60	60	60
7	70	10	18	23	35	35	35	70	70	70	70	70	70	70	70	70
8	80	10	20	27	40	40	40	40	80	80	80	80	80	80	80	80
9	90	10	18	30	30	45	45	45	45	90	90	90	90	90	90	90
10	100	10	20	25	33	50	50	50	50	50	100	100	100	100	100	100
11	110	10	22	28	37	37	55	55	55	55	55	110	110	110	110	110
12	120	10	20	30	40	40	60	60	60	60	60	60	120	120	120	120
13	130	10	22	26	33	43	43	65	65	65	65	65	65	130	130	130
14	140	10	20	28	35	47	47	70	70	70	70	70	70	70	140	140
15	150	10	21	30	38	50	50	50	75	75	75	75	75	75	75	150
16	160	10	20	27	40	40	53	53	80	80	80	80	80	80	80	80
17	170	10	21	28	34	43	57	57	57	85	85	85	85	85	85	85
18	180	10	20	30	36	45	60	60	60	90	90	90	90	90	90	90
19	190	10	21	27	38	48	48	63	63	63	95	95	95	95	95	95
20	200	10	20	29	40	50	50	67	67	67	100	100	100	100	100	100
21	210	10	21	30	35	42	53	70	70	70	70	105	105	105	105	105
22	220	10	20	28	37	44	55	55	73	73	73	110	110	110	110	110
23	230	10	21	29	38	46	58	58	77	77	77	77	115	115	115	115
24	240	10	20	30	40	48	60	60	80	80	80	80	120	120	120	120
25	250	10	21	28	36	50	50	63	63	83	83	83	83	125	125	125
26	260	10	20	29	37	43	52	65	65	87	87	87	87	130	130	130
27	270	10	21	30	39	45	54	68	68	90	90	90	90	90	135	135
28	280	10	20	28	40	47	56	70	70	70	93	93	93	93	140	140
29	290	10	21	29	36	48	58	58	73	73	97	97	97	97	97	145
30	300	10	20	30	38	50	60	60	75	75	75	100	100	100	100	150

This table is based upon the assumptions that the child care is 10 hours in length (TO) and that the full enrollment is present for the full 10 hours (TH). This is unlikely to ever occur but it gives us a reference point to measure adult child contact hours in the most efficient manner. Based upon the relationship between TO and TH, select from one of the formulae from the previous page (1-4) to determine how well the actual Relatively Weighted Contact Hours (RWCH) match with this table. If the RWCH exceed the respective RWCH in this table, then the facility would be over ratio on ACR and exceed group size standards.

Based upon the above tables classifications, the following figure provides a hypothesized relationship between the various contact hour (CH) levels of blue, green, yellow, and red and the ranges these color schemes represent as per COVID19 infections.



The above figure's hypothesized results projects that as the level of Contact Hours (CH) increases, a corresponding increase in COVID19 infections in adults and children would also occur in the child care facility starting off slowly at the lowest level of CH (Blue), increasing slightly (Green), but then a steeper curve (Yellow), and steepest at the Red level where CH would be at the highest representing the greatest number of children and adults present over time.

The proposed pilot study will test this hypothesis to determine if this is the case or not[2].

Notes:

1 The seven (7) questions should be asked of each grouping that is defined by a classroom or a well defined group within each classroom tied to a specific adult-child ratio.

2 The results from this pilot study could lead to interesting planning for the future in which a particular threshold could be identified where the infection rates are too high or where infection rates begin.

Additional information regarding this methodology can be obtained from contacting: Dr Richard Fiene, Research Psychologist, Research Institute for Key Indicators, & Penn State University. RFiene@RIKInstitute.com or RJF8@psu.edu. http://RIKInstitute.com

Contact Hours as a New Metric Replacing Group Size and Staff-Child Ratios as well as a New Metric for COVID19 Thresholds

Richard Fiene, Ph.D.
Research Institute for Key Indicators
Sonya Stevens, Ed.D.
Washington Department of Children, Youth and Families

May 2021

The purpose of this paper is to propose Contact Hours as a new metric replacing staff child ratios and group size as well as using it as a new threshold measure for COVID19 thresholds. This paper will attempt to validate the key parameters for testing out the Contact Hour (CH) methodology in a series of facilities to determine its efficacy. The pilot validation study will determine if this CH methodology has any merit in being able to measure regulatory compliance with adult-child ratios. Since monitoring of facilities will not be occurring during the COVID19 pandemic are there ways to measure the research question in the previous sentence. Yes there is and it is based upon the Contact Hour (CH) methodology and involves asking the following six questions (The six questions should be asked of each grouping that is defined by a classroom or a well-defined group within each classroom tied to a specific adult-child ratio.):

1. **When does your first teaching staff arrive or when does your facility open (TO1)?**
2. **When does your last teaching staff leave or when does your facility close (TO2)?**
3. **Number of teaching/caregiving staff (TA)?**
4. **Number of children on your maximum enrollment day (NC)?**
5. **When does your last child arrive (TH1)?**
6. **When does your first child leave (TH2)?**

After getting the answers to these questions, the following formulae can be used to determine contact hours (CH) based upon the relationship between when the children arrive and leave (TH) and how long the facility is open (TO):

(1) CH = ((NC (TO + TH)) / 2) / TA;

(2) CH = (NC x TO) / TA;

(3) CH = ((NC x TO) / 2) / TA;

(4) CH = (NC^2) / TA

Where: CH = Contact Hours; NC = Number of Children; TO = Total number of hours the facility is open (TO2 - TO1); TA = Total number of teaching staff, and TH = Total number of hours at full enrollment (TH2 - TH1).

By knowing the number of contact hours (CH) it will be possible to rank order the exposure time of adults with children. Theoretically, this metric could then be used to determine that the greater contact hours is correlated with the increased non-regulatory compliance with adult-child ratios as determined in the below table on page 2.

Table 1: Contact Hour (CH) Conversion Table (RS Model(1.0)) (Fiene, 2020©)

Taking into Account Exposure Time and Density

Group Size, Staff Child Ratio, Number of Children and Staff

<---------- Adult-Child Ratios (Relatively Weighted Contact Hours) ---------->

NC	CH	1:1	2:1	3:1	4:1	5:1	6:1	7:1	8:1	9:1	10:1	11:1	12:1	13:1	14:1	15:1
1	8	**8**	8	8	8	8	8	8	8	8	8	8	8	8	8	8
2	16	**8**	**16**	16	16	16	16	16	16	16	16	16	16	16	16	16
3	24	**8**	12	**24**	24	24	24	24	24	24	24	24	24	24	24	24
4	32	**8**	**16**	16	**32**	32	32	32	32	32	32	32	32	32	32	32
5	40	**8**	13	20	20	**40**	40	40	40	40	40	40	40	40	40	40
6	48	**8**	**16**	**24**	24	24	**48**	48	48	48	48	48	48	48	48	48
7	56	**8**	14	19	28	28	28	**56**	56	56	56	56	56	56	56	56
8	64	**8**	**16**	21	**32**	32	32	32	**64**	64	64	64	64	64	64	64
9	72	**8**	14	**24**	24	36	36	36	36	**72**	72	72	72	72	72	72
10	80	**8**	**16**	20	27	**40**	40	40	40	40	**80**	80	80	80	80	80
11	88	**8**	15	22	29	29	44	44	44	44	44	**88**	88	88	88	88
12	96	**8**	**16**	**24**	**32**	32	**48**	48	48	48	48	48	**96**	96	96	96
13	104	**8**	15	21	26	35	35	52	52	52	52	52	52	**104**	104	104
14	112	**8**	**16**	22	28	37	37	**56**	56	56	56	56	56	56	**112**	112
15	120	**8**	15	**24**	30	**40**	40	40	60	60	60	60	60	60	60	**120**
16	128	**8**	**16**	21	**32**	32	43	43	**64**	64	64	64	64	64	64	64
17	136	**8**	15	23	27	34	45	45	45	68	68	68	68	68	68	68
18	144	**8**	**16**	**24**	29	36	**48**	48	48	**72**	72	72	72	72	72	72
19	152	**8**	15	22	30	38	38	51	51	51	76	76	76	76	76	76
20	160	**8**	**16**	23	**32**	**40**	40	53	53	53	**80**	80	80	80	80	80
21	168	**8**	15	**24**	28	34	42	**56**	56	56	56	84	84	84	84	84
22	176	**8**	**16**	22	29	35	44	44	59	59	59	**88**	88	88	88	88
23	184	**8**	15	23	31	37	46	46	61	61	61	61	92	92	92	92
24	192	**8**	**16**	**24**	**32**	38	**48**	48	**64**	64	64	64	**96**	96	96	96
25	200	**8**	15	22	29	**40**	40	50	50	67	67	67	67	100	100	100
26	208	**8**	**16**	23	30	35	42	52	52	69	69	69	69	**104**	104	104
27	216	**8**	15	**24**	31	36	43	54	54	**72**	72	72	72	72	108	108
28	224	**8**	**16**	22	**32**	37	45	**56**	56	56	75	75	75	75	**112**	112
29	232	**8**	15	23	29	39	46	46	58	58	77	77	77	77	77	116
30	240	**8**	**16**	**24**	30	**40**	**48**	48	60	60	80	80	80	80	80	**120**

This table is based upon the assumptions that the child care is 8 hours in length (TO) and that the full enrollment is present for the full 8 hours (TH). This is unlikely to ever occur but it gives us a reference point to measure adult child contact hours in the most efficient manner. Based upon the relationship between TO and TH based upon the algorithms, select from one of the formulae from the previous page (formulae 1 - 4) to determine how well the actual Relatively Weighted Contact Hours (RWCH) match with this table. If the RWCH exceed the respective RWCH in this table, then the facility would be over ratio on ACR standards, in other words, they would be overpopulated.

(RS Model = 1.0)

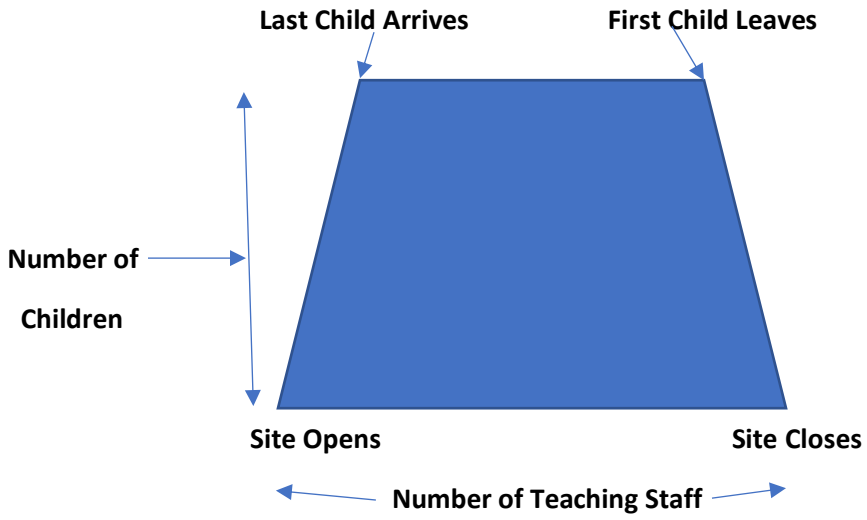
(TT Model = 0.5)

Sample/Data Collection Methods

Child care attendance data was explored and collected in partnership with the Washington State Department of Children, Youth, and Families (DCYF). A convenient sample of center and school age providers was initially identified through the use the state subsidy electronic payment system. All providers who accept Working Connections Child Care subsidies are required to use and track child attendance using an electronic attendance system. Providers may use and electronic sign in and out system provided by the state or opt to use another system. For this validation process, the sample was identified from the attendance tracking system provided and operated by DCYF and was inclusive of providers who use the system to track attendance of both subsidy and private pay children. The search resulted in approximately 100 providers within the State of Washington who have opted to use the electronic check-in system for all children regardless of payment type.

The sample was prioritized by identifying a single week since the Covid-19 outbreak began and from there the highest attendance day for that week was chosen for each provider. From this narrowed data set, it was determined the exact time the last child for the chosen day checked in, when the first child left, how many children were in attendance that day and the regular operating hours of the center or school age program. Because the attendance tracking system does not also track staffing attendance, it was necessary to contact each provider by phone in order to gather data inclusive of when the first staff arrived and when the last staff left and the total staff working that day. All responses were voluntary. Additionally, providers confirmed operating hours (many had been temporarily adjusted due to lowered demand during the gubernatorial stay at home order). Finally, providers reported if a child or staff member had tested positive for Covid-19. Of the 100 phone calls, the final sample was inclusive of 88 licensed providers statewide. Twelve providers either did not answer the call or opted to not answer the questions.

Figure 1: Contact Hour Diagram Paradigm and Schematic



The above diagram (Figure 1) depicts how the number of staff and children help to construct the contact hour formula. Depending on when the children arrive and leave could change the shape from a trapezoid to a rectangle or square or triangle. Please see the following potential density distributions which could impact these changes in the above contact hour diagram (Figure 1).

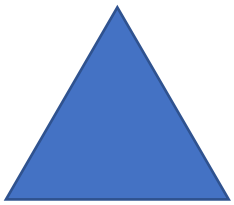
Potential Density Distributions
Taking into Account Number of Children, Staff, and Exposure Time

Here are some basic key relationships or elements related to the Contact Hour (CH) methodology.

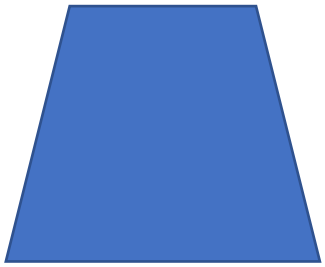
- RWCH = ACR
- CH = GS = NC
- NC and CH are highly correlated
- ACR and GS are static, not dynamic
- CH makes them dynamic by making them 2-D by adding in Time (T)
- ΣACR = GS
- GS = total number of children NC
- ACR = children / adult

ACR = Adult Child Ratio, GS = Group Size, RWCH = Relatively Weighted Contact Hours, NC = Number of Children.

Possible Density Displays of Contact Hours (Horizontal Axis = Time (T); Vertical Axis = NC):



This density distribution should result in the lowest CH but probably not very likely to occur. Essentially what would happen is that full enrollment would be a single point which means that the last child arrives when the first child is leaving. Very unlikely but possible. (TT Model Reference(0.5))



This density distribution is probably the most likely scenario when it comes to CH in which the children gradually, albeit rather steeply, arrive at the facility and also leave the facility gradually. They don't all show up at the same time nor leave at the same time. However, the arriving and leaving will be a rather close time frame. (TT Model)

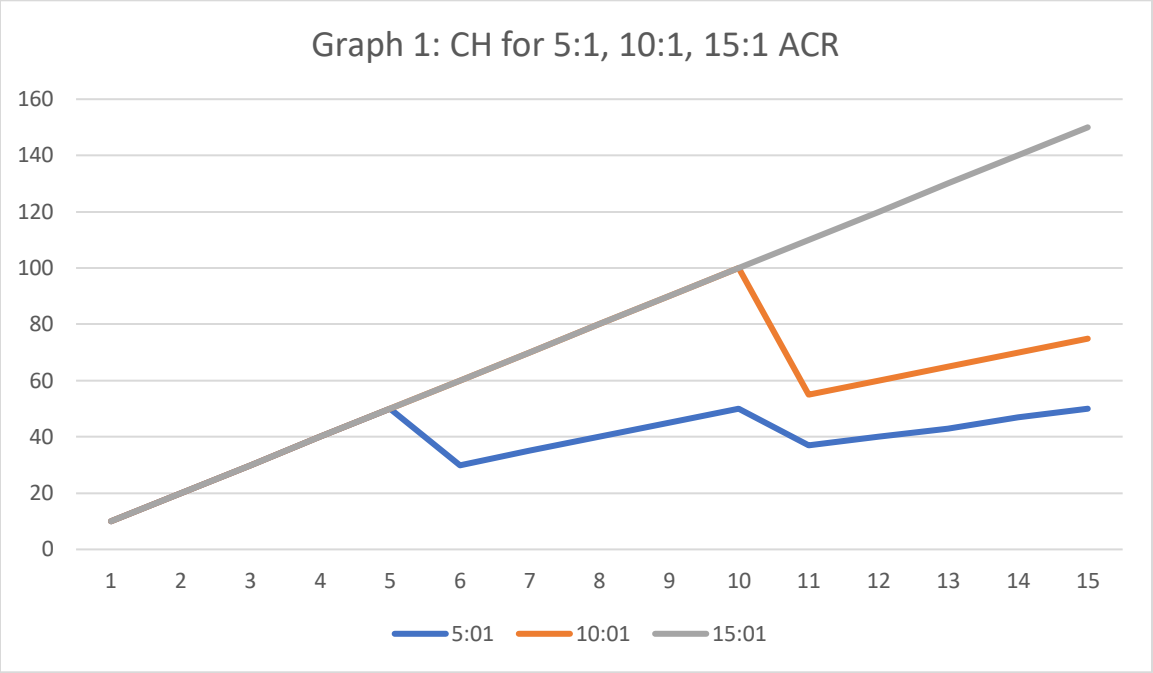
This scenario is unlikely but is used as the reference point for CH because it provides the most efficient model. This is where all the children arrive and leave at the same time. Very unlikely, but I guess it could happen. The important element here is its efficiency in that all contact hours are covered, so although a lesser amount of CH is not as efficient it does demonstrate compliance with ACR and GS which is one of the purposes of CH. As the bottom two distributions will demonstrate, CHs above this level would either depict a program that is open for an extended time or where there are too many children present and the facility is out of compliance with GS and/or ACR. (RS Model Reference(1.0))

This distribution would indicate that the facility is open for an extended time and exceeds the number of total CH as depicted in the reference square standard. Although not out of compliance with GS or ACR, this could become a determining factor when looking at the potential overall exposure of adults and children when we are concerned about the spread of an infectious diseases, such as what happened with COVID19. Are facilities that high CH because of a scenario distribution of this type more prone to the spread of infectious diseases? (RS Model)

This depiction clearly indicates a very high CH and non-compliance with ACR and GS. This is the reason for designing the CH methodology which was to determine these levels of regulatory compliance as its focus. (RS Model)

There is some overlap in the RWCH (Table 1 on page 2) in moving across the various levels, that occurs because of the change in group size (GS) where an overall group size (GS) could influence the overall CH by increasing NC.

The below graph (Graph 1) depicts the contact hours (CH) for three different adult to child ratios (ACR) 5:1, 10:1 and 15:1 to demonstrate the relationship between CH & ACR as the number of children (NC) increases. CH is along the vertical axis, with NC along the horizontal axis.

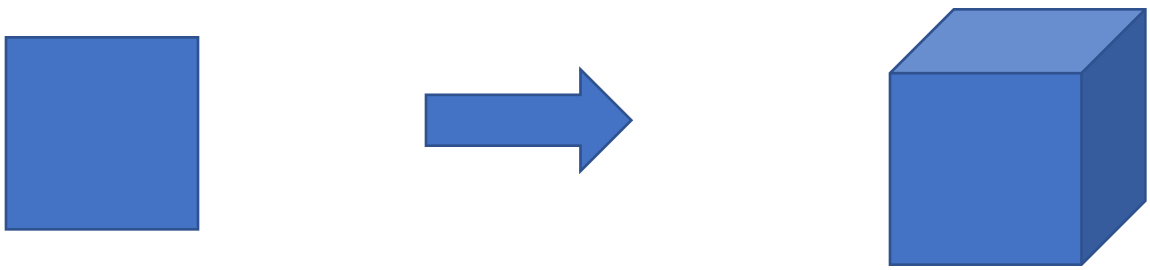


This graphic (Graph 1) depicts how with the addition of staff, the CH drop off accordingly.

****

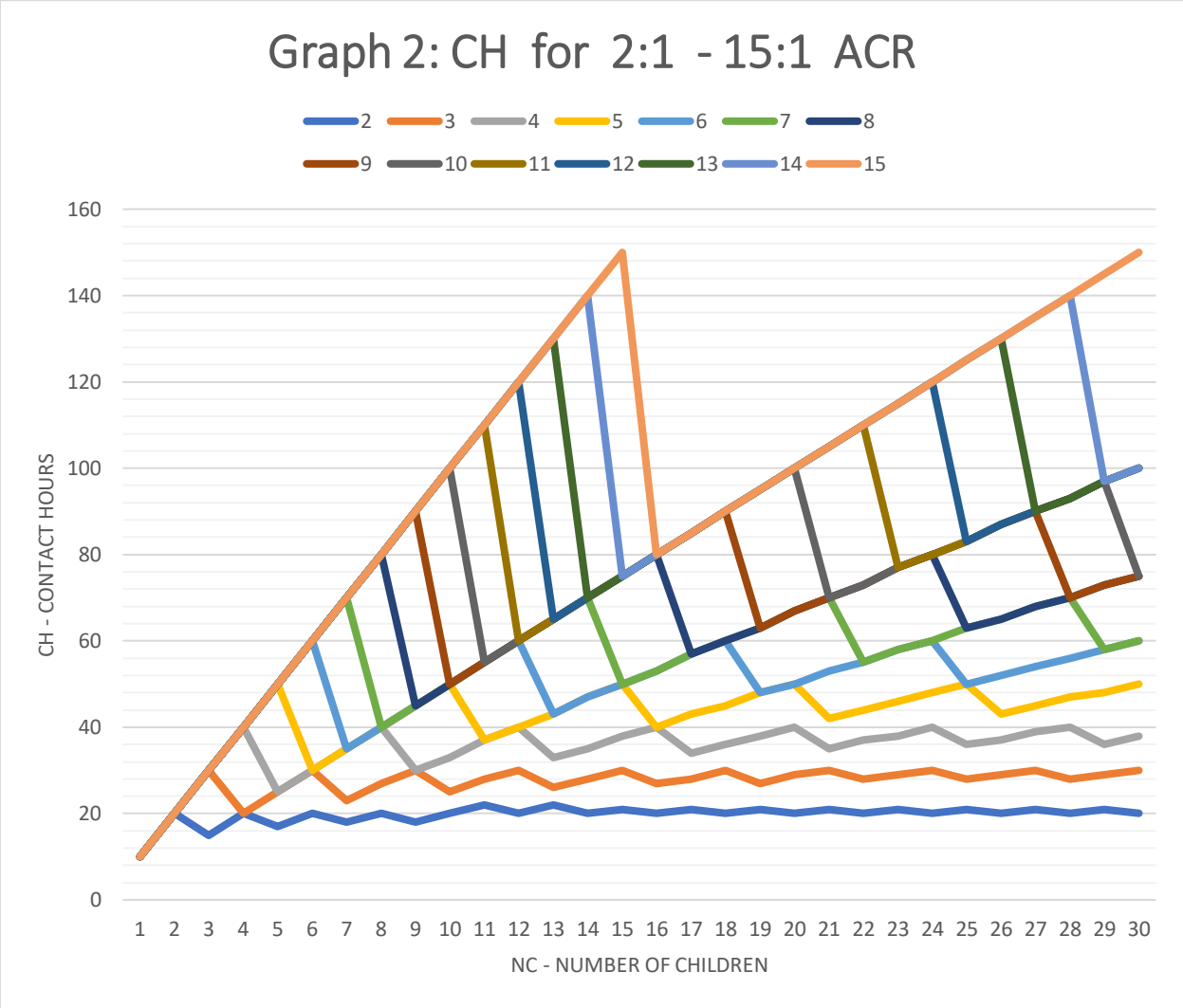
A possible extension or the next level to the CH methodology is to move from 2-D to 3-D and make the CH block format rather than area format. It could be used to describe the trilemma of accessibility, affordability and quality more fully. It could be a means for determining the unit cost at a much finer level and could then be used to make more informed decisions about the real cost of services.

Or another way of moving to 3-D is to include the square footage of the classroom or facility which would then provide a space metric along with time exposure and density metrics.



The move from 2-D (GS, ACR) to 3-D (GS, ACR, Quality or SQFT) and its potential impacts on the density distributions. Utilizing SQFT as a distancing/space dimension does help to mitigate the increased CH.

The following graph (Graph 2) depicts the Contact Hours (CH) for all the various Adult-Child ratios (ACR) in the Table on page 2 of this paper and how CH change with the number of children (NC).



From the above graph (Graph 2) it clearly shows how CHs vary with the number of children present. Please note the various slopes of the respective lines for each of the ACRs. As can be seen, once the lines begin to fluctuate, the CHs are entering into a zone of higher rate of exposure based on the ACRs. This demonstrates that the lower the ratio the more stable the CH line.

This is a listing of the algorithms for determining which formula (1-4 from page 1) & which model (RS or TT) to use in order to calculate the Contact Hours (CH). NC = Number of Children; TO = Total number of hours facility is open; TH = Total number of hours at full enrollment; TA = Total number of adult staff:

If TO = TH = NC, then (NC x TO)/TA = CH (RS Model)

If TH < TO, then ((NC (TO + TH))/2)/TA = CH; or If TH = 0, then ((NC x TO)/2)/TA = CH (TT Model)

If TO = TH < NC, then (NC x TH)/TA = CH (RS Model)

If TO = TH > NC, then (NC x TO)/TA = CH (RS Model)

Based upon the Washington State data, the Contact Hour methodology was validated in being able to act as a screener with those programs that would have exceeded the required staff child ratios. As can be seen through the data the more contact hours a staff person has with more children increases the probability of infection rates; when educators spend less time with lower amounts of children there is a lower chance of infection and vice versa. These data demonstrate how this methodology was used to assist in predicting appropriate child to adult ratios during an outbreak or pandemic by identifying safety thresholds of adult child ratios in licensed early learning facilities. The following spreadsheet plays out several scenarios with the actual data from Washington State early learning sites. For individuals interested in using the below spreadsheet in their respective jurisdiction, please contact the authors for the actual templates[1].

This provides evidence to support the use of this methodology in determining staff child ratio virtually as well as identifying when those ratios allow for in-person inspections or indicate when it is more appropriate to conduct virtual inspections. The authors do want to caution licensing administrators in that the results from this methodology is not to substitute for on-site observations when they are possible. It is intended as a screening tool to determine in a very overarching way how to target limited observational visits. The methodology is based upon statistical probabilities which have demonstrated in this pilot study to be highly reliable and valid but they are not full proof. So with any programs where there is any doubt, the agency should follow up with a direct observational inspection. Finally, agencies may want to consider using medical and geographical outbreak data in conjunction with this methodology to refine the results given the unique nature of the various infectious diseases.

In using the actual data from Washington State in the following spreadsheet, please note that the potential spread of the virus is mitigated the most greatly in the results in Green while Yellow and Red provide less mitigation and begin to place the adults and children at greater risk. Examples are provided for both the RS (1.0) and TT (0.5) Models

As a footnote to this study, a follow-up is to introduce distance/spacing via square footage (SQFT) to the Contact Hour formula. The results indicate a significant mitigation effect on increased Contact Hours when the available square footage is increased. This addition will be used in future studies to ascertain its relative impact on the Contact Hour formulas as indicated in the following revision.

CH2 = (((NC (TO + TH)) / 2) / TA) / (SQFT);

CH2 = ((NC x TO) / TA) / (SQFT);

CH2 = (((NC x TO) / 2) / TA) / (SQFT);

CH2 = ((NC^2) / TA) / (SQFT)

---

[1] Richard Fiene, Ph.D., Research Psychologist, Research Institute for Key Indicators and Affiliate Professor, Prevention Research Center, Penn State University. rjf8@psu.edu; http://prevention.psu.edu/people/fiene-richard

Sonya Stevens, Ed.D., Research Manager, Washington Department of Children, Youth, and Families, Olympia, Washington. Sonya.Stevens@dcyf.wa..gov

Contact Hour Models

NC	TA	TO	TH	TO+TH	(TOTH)N	CH	*RWCH*	RS Model - ACRCH 5:01	10:01	15:01
10	2	8	8	16	160	80	*40*	40	80	80
20	1	12	8	20	400	200	*200*	40	80	80
30	1	12	7	19	570	285	*285*	40	80	120
5	1	8	8	16	80	40	*40*	40	40	40
15	2	8	8	16	240	120	*60*	40	60	120
9	2	12	9	21	189	94.5	*47.25*	40	80	107

NC	TA	TO	NCxTO	CH	*RWCH*	TT Model - ACRCH 5:01	10:01	15:01
10	2	8	80	40	*20*	20	40	40
20	1	8	160	80	*80*	20	40	40
30	3	8	240	120	*40*	20	40	60
5	1	8	40	20	*20*	20	20	20
15	2	8	120	60	*30*	20	30	60
25	1	8	200	100	*100*	20	33	52

TT Model = CH=((NC(TO+TH))/2)/TA=RWCH; CH=((NCxTO)/2)/TA=RWCH; if TH<TO or if TH=0

RS Model = CH=(NCxTO)/TA=RWCH; CH=(NC2)/TA=RWCH; if TO=TH=NC or if TO=TH<NC or if TO=TH>NC

Decisions:

Green = meets or under with all ACRs

Yellow = meets, under and over with ACRs

Red = over with all ACRs

Legend:

NC = Number of Children in attendance

TA = Number of Teaching Staff

TO = Number of hours site is open

TH = Number of hours site at full enrollment

CH = Contact Hours with Children

RWCH = Relatively Weighted Contact Hours with Staff

Questions:

1) Number of children in attendance on your maximum enrollment day (NC)?

2) Number of teaching/caregiving staff on that same maximum enrollment day (TA)?

3) When does your first teaching staff arrive or when does your facility open (TO1)?

4) When does you last teaching staff leave or when does your facility close (TO2)?

5) When does you last child arrive (TH1)?

6) When does your first child leave (TH2)?

TO = TO2-TO1

TH = TH2-TH1

Table of Conversions - RS Model - ACRCH (Relatively Weighted Contact Hours)

NC	CH	1:01	2:01	3:01	4:01	5:01	6:01	7:01	8:01	9:01	10:01	11:01	12:01	13:01	14:01	15:01
1	8	**8**	8	8	8	8	8	8	8	8	8	8	8	8	8	8
2	16	**8**	**16**	16	16	16	16	16	16	16	16	16	16	16	16	16
3	24	**8**	12	**24**	24	24	24	24	24	24	24	24	24	24	24	24
4	32	**8**	**16**	16	**32**	32	32	32	32	32	32	32	32	32	32	32
5	40	**8**	13	20	20	**40**	40	40	40	40	40	40	40	40	40	40
6	48	**8**	**16**	**24**	24	24	**48**	48	48	48	48	48	48	48	48	48
7	56	**8**	14	19	28	28	28	**56**	56	56	56	56	56	56	56	56
8	64	**8**	**16**	21	**32**	32	32	32	**64**	64	64	64	64	64	64	64
9	72	**8**	14	**24**	24	36	36	36	36	**72**	72	72	72	72	72	72
10	80	**8**	**16**	20	27	**40**	40	40	40	40	**80**	80	80	80	80	80
11	88	**8**	15	22	29	29	44	44	44	44	44	**88**	88	88	88	88
12	96	**8**	**16**	**24**	**32**	32	**48**	48	48	48	48	48	**96**	96	96	96
13	104	**8**	15	21	26	35	35	52	52	52	52	52	52	**104**	104	104
14	112	**8**	**16**	22	28	37	37	**56**	56	56	56	56	56	56	**112**	112
15	120	**8**	15	**24**	30	**40**	40	40	60	60	60	60	60	60	60	**120**
16	128	**8**	**16**	21	**32**	32	43	43	**64**	64	64	64	64	64	64	64
17	136	**8**	15	23	27	34	45	45	45	68	68	68	68	68	68	68
18	144	**8**	**16**	**24**	29	36	**48**	48	48	**72**	72	72	72	72	72	72
19	152	**8**	15	22	30	38	38	51	51	51	76	76	76	76	76	76
20	160	**8**	**16**	23	**32**	**40**	40	53	53	53	**80**	80	80	80	80	80
21	168	**8**	15	**24**	28	34	42	**56**	56	56	56	84	84	84	84	84
22	176	**8**	**16**	22	29	35	44	44	59	59	59	**88**	88	88	88	88
23	184	**8**	15	23	31	37	46	46	61	61	61	61	92	92	92	92
24	192	**8**	**16**	**24**	**32**	38	**48**	48	**64**	64	64	64	**96**	96	96	96
25	200	**8**	15	22	29	**40**	40	50	50	67	67	67	67	100	100	100
26	208	**8**	**16**	23	30	35	42	52	52	69	69	69	69	**104**	104	104
27	216	**8**	15	**24**	31	36	43	54	54	**72**	72	72	72	72	108	108
28	224	**8**	**16**	22	**32**	37	45	**56**	56	56	75	75	75	75	**112**	112
29	232	**8**	15	23	29	39	46	46	58	58	77	77	77	77	77	116
30	240	**8**	**16**	**24**	30	**40**	**48**	48	60	60	80	80	80	80	80	**120**

RS Model = 1.0

TT Model = 0.5

The above examples are drawn from a pilot study done with Washington DCYF ECE facilities.