New Considerations for Survey Researchers When Planning and Conducting RDD Telephone Surveys in the U.S. With Respondents Reached via Cell Phone Numbers

AAPOR Cell Phone Task Force

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INTRODUCTION

The telephone has been a primary form of surveying the general public in the United States since the 1980s. However, as more of the general population has begun to use cell phones, including those who have given up their landlines entirely, telephone survey researchers have had to learn how to reach sampled persons on cell phone numbers in order to adequately cover the general population. With the rapid explosion of cell phone only households in the past decade, now estimated to exceed 25 percent of all U.S. households, it became clear that most telephone surveys of the general population would require a combination of sample reached via a landline and sample reached via a cell phone. In particular, young adults in the U.S. aged 18 to 34 years, can no longer be reached successfully via the landline frame. Thus, the inclusion of the cell phone frame to reach young adults and other demographic groups (e.g., renters and Hispanics) most likely to use cell phones has become a necessity for telephone survey researchers. Although the inclusion of cell phone numbers into surveys of the general population greatly enhances the ability to reach representative samples of the U.S. public, calling cell phone numbers also presents researchers with many difficult and costly challenges to overcome.

Since the release of the American Association for Public Opinion Research's 2008 Cell Phone Task Force Report, the survey research community has conducted many studies addressing different aspects of cell phone surveying in the United States. This 2010 report addresses the opportunities researchers can gain from incorporating cell phone numbers into their surveys, as well as the many challenges that surveying cell phone numbers in the U.S. presents. The report also provides some new insights into and recommendations for conducting survey research via cell phone.

EXECUTIVE SUMMARY

The reliability and validity of random digit dial (RDD) landline telephone surveying in the United States has been threatened in the past two decades by concerns about possible nonresponse bias. It has been further threatened in the past decade by concerns about possible noncoverage bias linked in part to a growing number of households giving up their landline telephone and embracing a cell phone only (also called "wireless only") lifestyle.

To address the latter concern, during the last eight years researchers in the U.S. began to explore the promise and challenges of surveying persons reached via their cell phone number. On the positive side, experience has shown that a markedly different demographic mix of the general population of the U.S. can be interviewed when sampling from the cell phone RDD frame, compared to when sampling from the landline RDD frame. In particular, the highly elusive young adult cohort in most landline RDD surveys is relatively easy to find and interview in cell phone RDD surveys. But unlike the case with most of the rest of the world, cell phone surveying in the U.S. presents researchers with many challenges if valid and reliable data are to be gathered.

In 2007, a volunteer Cell Phone Task Force was established by Executive Council of the American Association for Public Opinion Research (AAPOR) to prepare a report that would provide telephone survey researchers with information that should be considered when planning and implementing telephone surveys with respondents who are reached via cell phone numbers in the United States. That report was issued by AAPOR in the spring of 2008 and identified a number of areas in which knowledge gaps about cell phone surveying existed and needed to be closed.

Since that time the survey research community has conducted many studies about different aspects of cell phone surveying in the U.S., thus advancing the state of knowledge in this field considerably. Recognizing this, AAPOR's Executive Council decided in 2009 that the Cell Phone Task Force should be reconstituted in order to update the 2008 report to reflect the new knowledge that has been gained in the past two years from (a) a number of empirical studies built into cell phone surveys and (b) the wealth of new experiences gained by cell phone telephone survey practitioners in the United States.

The current report addresses many issues that apply primarily to RDD surveys that sample cell phone numbers, either as stand-alone cell phone surveys or as part of dual frame cell phone and landline RDD surveys. However, some of the matters discussed in this report apply to all surveys in the U.S. that reach cell phone numbers.

The new report covers the same major topics addressed in the 2008 report but with considerably more detail. This new report also addresses other major topics, which could not be addressed when the first report was written because knowledge was then insufficient.

In approaching the charge given to it by AAPOR's Executive Council, the 2009-2010 Cell Phone Task Force concluded that it remains premature to try to establish "standards" on the various issues as it is too soon in the history of surveying respondents in the U.S. reached via cell phone numbers to know with great confidence what should and should not be regarded as a "best practice." Nonetheless, a great deal has been learned during the past eight years, and in particular in the past two years, by those thinking about and conducting such surveys in the U.S. The Task Force agreed fully that it was time for AAPOR to update the information contained in this report. This information identifies a wide range of "guidelines" and "considerations" about cell phone surveying in the U.S. for researchers to consider explicitly.

As part of the process of creating this report, Task Force members met several times via telephone conference calls from June 2009 through April 2010, and established working subcommittees to address each of the following interrelated seven subject areas:

- Coverage and Sampling (Linda Piekarski, Chair)
- Nonresponse (Charlotte Steeh, Chair)
- Measurement (Scott Keeter, Chair)
- Weighting (John Hall, Chair)
- Legal and Ethical Issues (Howard Fienberg, Chair)
- Operational Issues (Anna Fleeman-Elhini, Chair)
- Costs (Thomas Guterbock, Chair)

What follows is a summary of each of the major sections of the report:

Coverage and Sampling. The RDD cell phone frame extends coverage of the general population in the U.S. to many demographic groups (young adults, males, minorities, etc.) that have become woefully hard to survey via the landline RDD frame. Thus, using the cell phone frame is very good for telephone survey researchers in terms of reaching more representative unweighted samples of the general public.

However, there are many coverage and sampling issues concerning cell phone numbers and frames that researchers must understand in order to evaluate the most appropriate design for telephone surveys in the United States. This section of the report lists many considerations that should be given to the decision of what frame(s) to use when planning to interview people in RDD surveys who are reached on a cell phone or a landline. The section also discusses the critical decision that researchers need to make about whether to choose an overlapping dual frame design (with no screening of the cell phone sample based on the respondent's telephone service type and usage) or a dual frame design with screening of the cell phone sample for cell phone only status (and possibly for cell phone mostly/mainly status). At this time, the Task Force does not think it is appropriate to always recommend one of these designs over the other. Instead, either design might be the better choice based on the particulars of a given survey.

The important issue of how to integrate landline sample with a cell phone sample is also addressed in this section. All of the coverage/sampling decisions are particularly challenging when a survey is less than national in scope.

Finally, whether RDD telephone surveys in the U.S. that sample cell phone numbers should deploy a within-unit respondent selection technique continues to remain unclear and awaits future research regarding (1) whether it needs to be done and if so, (2) when it should be done and (3) how best to do it.

Nonresponse. Nonresponse in RDD cell phone surveys is somewhat greater than in comparable RDD landline surveys in the U.S. However, as response in traditional landline RDD surveys has continued to drop, the differential between rates in RDD landline surveys and those in RDD cell phone surveys has narrowed.

Noncontacts and refusals as sources of nonresponse are somewhat more prevalent in cell phone surveys than in landline surveys with comparable numbers of callbacks. However, there are reasons to expect that the proportion of noncontacts in cell phone surveys will decrease over time. In contrast, there are formidable obstacles to addressing the challenges posed by refusals in RDD cell phone surveys that are likely to remain in the foreseeable future. For example, there are many reasons that refusal conversion attempts are less productive with RDD cell phone samples than they are with RDD landline samples.

The accurate dispositioning of the numbers in a sample, both on a temporary basis during the field period and on a final basis at the end of the field period, is more troublesome with cell phone samples. New disposition codes are needed for cell phone surveys and some codes used for landline surveys either have no relevance or mean something different in a cell phone survey.

Cell phone RDD surveys also pose more challenges than landline RDD surveys for call centers and researchers to determine many numbers for which eligibility remains uncertain at the end of the field period. This in turn makes the calculation of response rates for cell phone surveys more complex and less reliable than with landline surveys. This section of the report presents a discussion with examples about calculating a weighted overall dual frame response rate that combines the rates from the cell phone sample with the landline sample.

The processing of cell phone samples also requires many new operational considerations that are not faced in processing landline samples, and which will further increase nonresponse if not handled well. All of these challenges related to nonresponse in U.S. cell phone surveys make them more expensive to conduct than comparable landline surveys (see Costs section).

In terms of nonresponse bias in cell phone surveys, little is known. However, there is research that suggests that survey topics related to technology are likely to yield somewhat biased data due to differential nonresponse given the trend for those most technologically sophisticated to be more likely to agree to participate in a cell phone survey. Whether such bias can be reduced or eliminated through post-secondary weighting remains unclear. Much more research on this topic is needed in the coming years.

Measurement. There are two primary measurement issues concerning cell phone surveying. First, there is the concern about the potential for lower data quality associated with cell phone surveys. There are many reasons for this concern including factors associated with audio quality, asking about sensitive topics while a respondent is in a public place, and asking about cognitively complex topics while a respondent is multitasking.

Despite these concerns, most of the empirical evidence to date regarding cell phone respondents does not support the broad assumption of poorer data quality compared to what landline respondents provide. That is, there is no evidence to suggest that all or even most data gathered by cell phone are of poorer quality than their landline counterparts would be.

However, the reader is cautioned that "few significant differences" do not necessarily imply equivalence in data quality as there is some evidence to suggest that under certain circumstances, including when asking certain types of questions, concerns about cell phone data quality are not unfounded. Therefore, the Task Force believes it is advisable that researchers remain attentive to this data quality concern. Future experiment-based research (cf. Kennedy, 2010) is needed to know with confidence if, and how, data quality is affected by gathering it from a respondent on a cell phone.

Second, many new survey items may be needed for use in adjusting cell phone samples prior to analyzing their data. Examples of some of these items appear in Appendix B. However, as discussed in detail in the Weighting section of the report, the reliability and validity of these new items has not yet been established.

Weighting. This section focuses mostly on two types of RDD sampling designs: (1) non-overlapping dual frame designs and (2) overlapping dual frame designs. Weights would almost always be required if both cell and landline RDD frames are used, especially if respondents having both types of service are interviewed from both frames (i.e., the dual frame "overlapping" design without screening). However, there are a few instances when it may be permissible not to use weights. For example, weights might not be needed in a sample that uses only one frame and no attempt is made to generalize about those who could only be contacted via the other frame.

A good deal of discussion is presented in the section on steps that researchers should consider in applying weights to their cell phone and landline RDD samples in dual frame telephone surveys. Discussion also is provided about data that researchers should consider gathering from respondents to aid any post-stratification they may perform. Appendix B shows examples of questions some prominent survey organizations have used for these purposes.

However, there remain a number of important unknowns and uncertainties about the weighting needed to help improve the accuracy of RDD cell phone samples and this section of the report addresses the many questions that prudent researchers need to consider when thinking about weighting an RDD dual frame sample. This is the most complex and challenging set of knowledge gaps currently facing U.S. telephone researchers who work with data from RDD cell phone samples. Until reliable methods have been devised, tested, and refined by the survey research community, researchers will have to accept some uncertainty (and possible discomfort) regarding whether a cell phone survey data set has been made as accurate as it can be through weighting. A particularly troublesome issue here is that there is a dearth of highly accurate population parameters to use in weighting cell phone samples of regional, state and local areas.

Finally, the Task Force believes it is vitally important for researchers to disclose and clearly describe how they constructed any weights used in their analyses of cell phone survey data or to describe the basis on which they decided not to weight, if that was their decision.

Legal and Ethical Issues. Due to federal telecommunication laws and regulations in the U.S., those who conduct surveys with people who are reached on a cell phone must avoid using autodialers (including self-dialing modems and predictive dialers) to place calls, unless they have prior permission of the cell phone owner to do so. This increases the time and cost of processing RDD cell phone samples considerably.

Presently, it is not advised that text messages be used to make advanced contact with those sampled at a cell phone number due to federal and state laws on text messaging.

From an ethical perspective, the report addresses several cell phone related issues, including how to think about: (1) time of day for calling; (2) maximum number of callbacks and the frequency of callbacks so as to avoid harassment and avoid violating various state laws on

harassment via the telephone; (3) privacy issues; (4) safety issues; (5) contacting minors; (6) the permitted use of the Neustar databases; (7) transmitting accurate Caller ID information when dialing a cell phone; and (8) keeping an internal Do Not Call list for cell phone owners who request that they not be called back.

Operational Issues. In the past few years, a great deal has been learned about many important operational issues pertaining to conducting RDD cell phone surveys of the U.S. general population. As survey organizations gain more experience conducting surveys in the U.S. with respondents reached via their cell phones, greater confidence has resulted concerning the "best" approaches for generating quality data in cell phone surveys.

This section of the report includes detailed discussion of: (1) calling rules and protocols, including how to implement various types of eligibility screening that cell phone surveys often require and the differences between refusal conversion methods in cell phone surveys versus landline surveys; (2) differences between the processing of numbers from the two survey frames when planning callbacks and how to disposition certain calling outcomes in cell phone surveys compared to landline surveys; (3) the use of messages left on voice mail; and (4) how and when to implement remuneration and/or incentives with cell phone respondents.

Almost all of these operational issues affect how interviewers are trained to conduct cell phone surveys. The Task Force believes that interviewers should receive special training before they are assigned to cell phone surveys, and that ideally an interviewer should have experience with landline surveys before being trained to work on cell phone surveys. Discussion also is presented about the assignment of interviewers to cell phone surveys so as to avoid possible burn-out from the demoralizing effects of the very low productivity that often results when trying to complete interviews in cell phone surveys.

Cost Issues. During the past few years many survey firms have gained experience with the differential costs of conducting cell phone RDD surveys compared to landline RDD surveys. Extensive discussion is provided in this section of the report about factors that lead to differential costs between cell phone and landline surveys in the U.S., including: (1) the dialing method, (2) interviewer time, (3) cost of the sample, (4) remuneration, (5) working number rate, (6) contact rate, (7) eligibility rate, (8) cooperation rate, and (9) interview length.

The Task Force also conducted what we believe is the first survey of U.S. survey organizations known to have had experience in conducting dual frame telephone surveys. Details were gathered about various cost-related factors in 38 dual frame RDD surveys. Results from the survey present the differential costs between cell phone and landline surveys and how the differential in cost is associated with factors such as whether the survey used an overlapping or nonoverlapping sampling design and whether the survey was national or non-national in scope. The findings show that the cost per completion in a U.S. RDD cell phone survey is most often at least twice that of a completion in a U.S. RDD landline survey, and under certain design conditions can be three or four times as expensive.

The Cost section ends with a discussion of the "costs" to sampling precision (as indicated by *design effects* and *effective sample size*) when researchers make decisions about how to allocate their final dual frame sample between the cell phone or the landline frames. Appendix C provides discussion of a cost allocation model developed for the AP-GfK Poll that will help researchers think more clearly about the "costs" of the dual frame sampling designs they chose to deploy.

Recommendations. In addition to the suggestions and considerations discussed in the above sections of the report, the Task Force has made three recommendations concerning disclosure. These include the following: (1) researchers should explain the method by which the cell phone numbers used in a survey were selected, (2) if RDD telephone surveys do not sample cell phone numbers, then researchers should provide an explanation of how excluding cell phone owners might or might not affect the survey's results, and (3) researchers should explain the decisions that were made concerning weighting of cell phone samples, including why the sample was not weighted, if in fact that was the case.

Additional Readings and Glossary. The report lists additional readings from the large and growing research literature on RDD cell phone surveying in the U.S. and an updated glossary of terms related to cell phone surveys that may not be familiar to all readers.

Appendices. Three appendices are included to provide supplementary information about sampling, measurement, and costs:

- *Appendix A* (written by Michael Link of The Nielsen Company) covers "Address-Based Sampling (ABS) as an Alternative to Sampling Cell Phone Exchanges," and explains how the ABS frame provides an alternative approach for including cell phone only households/persons in a survey.

- *Appendix B* (assembled mostly by Leah Melani Christian of the Pew Research Center) covers "Examples of Questions Used by Major Survey Organizations for the Purposes of Weighting Cell Phone Samples," and lists the wording of many survey items from six major survey organizations that have been devised and used in the past few years for gathering information about telephone service and usage in the U.S. These are the data that are often needed to help weight dual frame telephone surveys.

- *Appendix C* (written by Robert Benford of GfK Custom Research North America) covers "Considerations for Sample Design, Estimates, Weighting and Costs," and provides a perspective on important implications that result when researchers decide how to apportion the total number of completions that will be achieved in dual frame telephone surveys between the landline and cell phone RDD frames.

BACKGROUND

The reliability and validity of random digit dial (RDD) landline telephone surveying in the United States has been threatened in the past two decades by concerns about possible nonresponse bias. Furthermore, it has been threatened in the past decade by concerns about possible noncoverage bias linked to a growing number of households giving up their landline telephone and embracing a cell phone only (also called “wireless only”) lifestyle.

To address the latter concern, researchers in the U.S. during the last eight years began to explore the promise and challenges of surveying persons reached via their cell phone number. On the positive side, as shown in Table 1, experience has revealed that a markedly different demographic mix of respondents can be interviewed when sampling the cell phone RDD frame compared to when sampling the landline RDD frame. In particular, the elusive young adult cohort in most landline RDD surveys is relatively easy to find and interview in cell phone RDD surveys. In addition, as also shown in Table 1, RDD cell phone surveys interview appreciably more minorities (blacks and Hispanics) and men than do RDD landline surveys. One of the many advantages this brings is unweighted samples that more closely match general population parameters when RDD cell phone completions are combined with RDD landline completions before substantive analyses are undertaken.

In theory, calling cell phones increases the chances of making contact with a sampled respondent, as contacts are no longer limited to those times when people are in their homes. Furthermore, a portion of previous non-telephone households in the U.S. are now using inexpensive cell phones on occasion. These heretofore unreachable households/persons in RDD landline surveys might now be reachable via an RDD cell phone survey.

The past decade has shown that as proportionally more people integrate the use of a cell phone into their daily lives, proportionally fewer people are reachable via a traditional landline telephone. This has further eroded the coverage of the general population that can be interviewed via the RDD landline frame. In turn, this has made use of the RDD cell phone frame increasingly more attractive (and necessary) for telephone survey researchers in the U.S.

In the past two years, there has been a noticeable shift away from landline-only RDD sampling to dual frame RDD designs in which both a landline frame and cell phone frame are used.

Table 1 Unweighted Respondent Demographics by Type of RDD Telephone Frame				
	Pew Research Center		The Associated Press	
Demographics	**Landline**	**Cell Phone**	**Landline**	**Cell Phone**
Sex				
Male	45%	57%	43%	59%
Female	55%	43%	57%	41%
Age				
18-34 years	13%	39%	11%	36%
35-64 years	56%	50%	61%	54%
65 years+	30%	10%	28%	10%
Race				
White	79%	67%	81%	74%
Black	8%	12%	7%	9%
Hispanic	6%	11%	6%	10%
Other	7%	10%	6%	7%
Education				
No College	37%	36%	26%	25%
Some College	25%	28%	28%	30%
College Grad	38%	35%	46%	45%
Sample Sizes	18,493	6,670	15,438	4,577

Note. The AP surveys were conducted in 2009 and 2010 by GfK-Roper. The Pew surveys were conducted in 2008 - 2010. Some of the Pew surveys were conducted by Abt SRBI and the others by PRSAI.

By 2010, these dual frame RDD designs had become the accepted approach to conducting a general population survey in the U.S. via telephone. Thus, it is imperative that the survey research community identify the most cost-effective ways to conduct dual telephone frame surveys and to do so in ways that provide confidence in the data that are gathered and minimize both coverage and nonresponse bias in the findings that are generated.

But unlike the case with most of the rest of the world, cell phone surveying in the U.S. presents researchers with many challenges to address if valid and reliable findings are to result. To that end, this report aims to help researchers who are conducting telephone surveys in the U.S. to understand the many issues and make informed decisions regarding cell phone surveys, especially those that are to be combined with a landline survey.

Prior History, the 2009-2010 AAPOR Cell Phone Task Force, and This Report

A volunteer AAPOR Cell Phone Task Force was established by the AAPOR Council in 2009 to revise and update the 2008 AAPOR report. The 2010 version is intended to provide survey researchers with information that should be considered when planning and implementing telephone surveys with respondents who are reached via cell phone numbers in the United States. This report is specific to the United States because the telecommunication regulatory and business environment that affects cell phone ownership and usage in the U.S. is quite different from that found in most other countries.

This report addresses the many issues that apply primary to RDD cell phone surveys. However some of the topics discussed also apply to all telephone surveys in the U.S. that reach a respondent on a cell phone device by design or otherwise.

Prior to working together on the 2009 - 2010 Task Force, 14 of the 21 members had worked together on the 2007 - 2008 AAPOR Task Force that issued the AAPOR cell phone surveying report in 2008. In addition, 10 of the members had worked together as far back as 2002 on prior initiatives concerning cell phones and telephone survey research in the U.S. In 2003, many of them were part of a group of approximately 25 academic, government, and commercial telephone survey experts who met for a two-day *Cell Phone Sampling Summit* in New York City, which was organized and sponsored by Nielsen Media Research. At this first summit, a wide

range of methodological and statistical issues related to cell phone surveying were discussed and many knowledge gaps identified. Following the 2003 summit, and with the generous support of the U.S. Chief Demographer, Chester E. Bowie, a series of questions were added to a 2004 Current Population Survey supplement to gather national data on the types of telephone services that households use. In 2005, the second two-day *Cell Phone Sampling Summit* was organized by Nielsen with a slightly larger group of U.S. telephone survey sampling experts attending.[1] At that second summit it was decided that the next meeting to address cell phone surveying in the U.S. should be open to all interested survey researchers. This was further discussed at the January 2006 *Telephone Survey Methods II* conference in Miami. Planning for the open meeting ensued shortly thereafter. What resulted was a three-day mini-conference within the larger 2007 AAPOR conference in Anaheim.[2] The mini-conference included a half-day short course on cell phone surveys, followed by seven consecutive paper and discussion sessions over the next two days. All of these meetings were extremely well attended. In addition, AAPOR Council approved the creation of a special issue of *Public Opinion Quarterly* (Volume 71, Number 5, 2007: Cell Phone Numbers and Telephone Surveying in the U.S.), that was published in December 2007.[3] Many of the members of the Task Force helped to conduct blind reviews of articles submitted to the special issue and/or contributed to the articles published in the special issue.

In approaching the charge given to it by AAPOR's Executive Council, and similar to the decision of the 2007 - 2008 Task Force, the 2009 - 2010 Task Force decided it was still premature to try to establish "standards" on the various methodological, statistical and operational issues. The Task Force thought it was too soon in the history of surveying respondents in the U.S. reached via cell phone numbers to know with confidence what should and should not be regarded as a "best practice." Nonetheless, it was recognized that a great deal had been learned during the past two years by those thinking about and conducting cell phone surveys in the U.S. The Task Force agreed fully that it was time for AAPOR to release updated information such as that contained in this report that identifies a wide range of "guidelines" and "considerations" about cell phone surveying in the U.S.

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[1] See http://www.aapor.org/AM/Template.cfm?Section=Do_Cell_Phones_Affect_Survey_Research_&Template=/CM/ContentDisplay.cfm&ContentID=2437

[2] Considerable appreciation goes to Patricia Moy, Rob Daves, and Frank Newport for their key support of this mini-conference as members of AAPOR Council and leaders of the 2007 AAPOR conference program.

[3] Considerable appreciation goes to Peter V. Miller, editor of *Public Opinion Quarterly*, for his consistent and crucial support in seeking approval of this special issue from AAPOR Council.

As part of the process of creating this report, the Task Force met several times via telephone conference calls from June 2009 through June 2010 and established seven working subcommittees to address each of the following interrelated subject areas:

- Coverage and Sampling (L. Piekarski, Chair)
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- Legal and Ethical Issues (H. Fienberg, Chair)
- Operational Issues (A. Fleeman-Elhini, Chair)
- Costs (T. Guterbock, Chair)

Each of the subcommittees created a first draft of their section, which was vetted by a meeting of the full Task Force in January 2010. Those sections were further revised and were reviewed by the full Task Force in April 2010. With the 2010 AAPOR conference held in May, the Task Force decided to attend presentations related to cell phone surveying and then meet after the conference to determine what in the report should be further updated or revised. The subsections were reviewed and revised in light of the new research presented at the 2010 AAPOR conference and a version of the Task Force report was sent to the AAPOR Council in July 2010. The report was voted on and approved at the AAPOR Council meeting on September 16, 2010.

Cell phone numbers can enter into telephone samples in several different ways. If the sample is selected from a list, such as members of organizations, or from telephone numbers matched to postal addresses, a researcher may not know whether the number belongs to a cell or a landline phone. Thus, list telephone samples, including those developed from address-based sampling frames most likely will be a mix of cell phone and landline numbers. In these cases, the inclusion of cell phone numbers has relatively little effect on the sampling process.[4] However, when the method for selecting a telephone sample is RDD, multiple dilemmas face the researcher including whether the designated sample contains only cell phone numbers, only

[4] In the U.S., all list samples for telephone surveys should be cleaned against cell phone and ported number databases or the researcher may inadvertently violate federal regulations if using an autodialer whenever prior consent to call a cell phone number has not been given by the cell phone owner.

landline numbers or both. This report addresses these dilemmas and focuses primarily on telephone surveys using RDD samples.

COVERAGE AND SAMPLING FOR RDD CELL PHONE SURVEYS

Declining Coverage of U.S. Landline Telephone Frames

The prevalence and use of cell phones in the U.S., also often referred to as "wireless" telephones, has been steadily increasing since 2000. As of 2009, more than 80 percent of adults had at least one wireless phone and a growing number of adults and households are replacing their landline telephone service with cell phone service. According to the National Center for Health Statistics (NCHS) the number of "*wireless-only households"* has grown from less than 2 percent in 2001 to 24.5 percent of all households by the end of 2009, a percentage that now exceeds that of "*landline-only households,"* which is now only 14.9 percent of households (Blumberg and Luke, 2010). These trends will certainly continue as time passes.

This means that a national RDD sample of landline telephone numbers generated from a frame that covers all U.S. landline households will represent less than 80 percent of telephone households and less than 75 percent of all households.

Moreover, modeled estimates for 2007 produced by NCHS and State Health Access Data Assistance Center (SHADAC) suggest that the prevalence of wireless-only (also called cell-only) households varied significantly by state; e.g., from a low of approximately 5 percent in Vermont in 2007 to a high of approximately 26 percent in Oklahoma in 2007 (Blumberg et al., 2009).[5] Research by Arbitron Inc. suggests that the prevalence of wireless-only also varies by market level within each state. Specifically, market level penetrations of wireless-only households vary by region and demographics such as age, race, and ethnicity, with higher penetrations in markets with college campuses and/or military bases and in high density Hispanic areas (Fleeman et al., 2010). For example, Fleeman and her colleagues cite the state of Illinois where the penetration of cell-only is 20 percent, whereas the various metropolitan area rates within Illinois range from 13 percent to 30 percent. As another example, the New York City metro area shows "significant differences among Long Island, the Boroughs and the New Jersey suburbs."

[5] The Task Force membership was not unanimous in its thinking about how accurate some of the NCHS/SHADAC state point estimates might be. There is always uncertainty about the utility of the model when a model is used to predict an outcome, and in this case the key determinants or predictors for estimating cell-only status are limited. This suggests that one should be cautious in using these estimates. Similar caution should be used with Arbitron's estimates as they were based on a model that included the NCHS/SHADAC state point estimates.

Equally important to researchers are the demographic attributes of these cell phone only households. As of 2009, the U.S. cell phone only population is more likely to be younger: 38 percent of 18- to 24-year-olds, 49 percent of 25- to 29-year-olds, and 37 percent of 30- to 35-year-olds live in wireless-only households (Blumberg and Luke, 2010). The cell phone only population also includes more renters, a higher proportion of non-whites (e.g., 30 percent of Hispanics), and has a lower income as compared to the entire U.S. landline population. Although cell phone only adults have tended to be unmarried cohabitants, the number of children living in cell phone only households is now growing. At the end of 2009, 40 percent of cell phone only adults were living with children (Blumberg and Luke, 2010). In addition to demographic differences, recent research by the Pew Research Center found differences between the cell-only and landline respondents in terms of political attitudes and behavior, media use, internet use and activity, social views and lifestyle behaviors (Christian et al., 2010). Similarly the NCHS (Blumberg and Luke, 2010) continues to find differences in health and health related behaviors.

Given the growing geographic and demographic biases that might result from excluding the cell phone only population, researchers may want to consider the option of a dual frame telephone sample design where a landline frame is augmented with that of a cell phone frame. Using dual frame (landline plus wireless) telephone samples is not the only approach to compensating for the increasing number of wireless only households absent from the landline RDD frame. For example, Address Based Sampling (ABS) can provide an alternative single frame approach as well. (See Appendix A for an overview of Address Based Sampling.)

Another intriguing alternative that is being explored by some researchers is the possibility of substituting directory-listed landline phone numbers (also called Electronic White Pages or EWP sample) for some of the entire landline RDD sample. Although it is well known that EWP samples underrepresent certain groups, these are the same groups that are fairly easily reached via cell phone, so they are covered to some extent in a dual frame design that combines cell phone and EWP samples. A dual frame study that uses only EWP sample and cell phone RDD sample (without screening) would cover all telephone households *except those that have an unlisted landline and no cell phone available*. An analysis of NHIS data by Guterbock and colleagues (2009) suggests that this segment is quite small and is shrinking, and

it is not highly different from the rest of the telephone universe, so the coverage error from its exclusion is likely to be very small for most survey results (Guterbock et al., 2010). [6]

U.S. RDD Cell Phone Frames and Types of Telephone Service

Frames for generating random digit dial (RDD) samples for conducting surveys of cell phones in the United States are available from most sample suppliers. These frames are lists of all possible wireless telephone numbers and are generally built using industry databases that identify the types of service provided by individual prefixes and 1000-blocks.[7]

Three important features of the U.S. RDD cell phone frames are:

- The available data in the frames are administrative and are subject to errors (e.g., a particular number may not be for a cell phone or a carrier has incorrectly classified or not updated some of their telephone information).
- There are no indicators in the frame, or in any other reliable source, that can accurately identify whether the number is currently working; where the subscriber of the number currently resides; or if the number is subscribed by a person who lives in a household with a landline telephone.
- There are no commercially available sources with subscriber information such as name, address, or any demographics that can be linked reliably to cell phone numbers on the frame.

[6] Since interviewing from a EWP sample is far more efficient than interviewing from a landline RDD sample, the savings from substituting EWP sample for landline RDD sample can substantially offset the incremental cost of including the cell phone RDD sample. A series of recent surveys by the University of Virginia Center for Survey Research has tested this approach in 'triple-frame' studies that combine landline RDD, EWP, and cell phone RDD samples. This three-sample approach affords some cost savings over the more usual dual frame design, while not fully abandoning the more expensive, traditional landline RDD sampling frame. This design has allowed direct comparison of survey estimates drawn from combining the EWP and cell phone samples with those obtained from combining landline RDD and cell phone samples, with promising results (Guterbock et al., 2010). (In the final results, unlisted phones in the two landline samples should be weighted upward so that their proportion among landlines is equal to that found in the landline RDD sample.) Although the University of Virginia has made regular use of the triple-frame design, it remains an experimental design that has not to date been adopted elsewhere, and many issues, such as proper weighting and optimal sample allocation, remain to be explored before its suitability for broader application can be fully assessed.

[7] Telephone numbers in the United States are comprised of 10 digits (123-456-7890). The first three numbers, 123, are the *area code*. The next three numbers, 456, are the *prefix* or *exchange*. The last four numbers, 7890, are the *local number* which can be divided into segments. A *thousand block* is comprised of 1,000 consecutive numbers for an area code and prefix in which the local "suffix" starts with the same digit, e.g., starting with 7 (7000-7999). A *hundred block* is the 100 consecutive numbers in which the local suffix starts with the same two digits, e.g., starting with 78 (7800-7899).

Because the wireless frame is administrative in nature, it only provides information about prefixes and 1000-blocks, such as service provider, rate center location, some rate information and the type of service provided. For example, below is a list of the types of service (NXX Type) that might contain cell phone numbers. (Note that the various NXX Types are explained in more detail in the glossary.)

04: Dedicated to Cellular
50: Shared Between Three or More Types of Service – (Plain Old Telephone Service (POTS), Cellular, Paging, Mobile or Miscellaneous)
40: Shared Between POTS and Cellular
55: Special Billing Option Cellular
58: Special Billing Option Shared Between two or More – Cellular, Paging, Mobile)
60: Service Provider Requests SELECTIVE Local Exchange – (IntraLATA Special Billing)
65: Personal Communications Services (PCS) – Also Wireless/Cell
66: Shared Between POTS and Personal Communications Services
67: Special Billing Option – PCS / Personal Communications Services
68: Service Provider Requests SELECTIVE Local Exchange – (IntraLATA Special Billing – PCS)

However, not all telephone numbers generated in these NXX types will be for cell phones. According to the U.S. Federal Communications Commission (FCC), as of September 30, 2009, approximately 181,000 wireless numbers had been ported (i.e. converted) to landline service (FCC, 2010). Although these numbers will be found in a cell phone frame, they will connect with a landline telephone. Shared service prefixes and 1000-blocks can contain numbers associated with both wireless and landline services.

Considerations When Purchasing a U.S. RDD Cell Phone Sample

The Sample Provider's Frame. When purchasing a sample of U.S. RDD cell phone numbers, researchers are encouraged to inquire about how the sample provider's frame has been constructed and approximately what percentage of cell phone numbers in the geographical area

to be surveyed are excluded from the provider's frame. Individual vendors may construct their frames differently.

The following is a list of issues researchers are encouraged to consider when purchasing RDD cell phone samples:

- Is the frame based on prefixes, 1000-blocks or 100-blocks?
- How often is the frame updated?[8]
- What types of wireless services are included: Dedicated? Shared? Cell? PCS? Special Billing?[9]
- What is the extent of noncoverage and overlap between the provider's landline frames and cell frames? What prefixes, 1000-blocks, or 100-blocks are excluded, and why? What prefixes, 1000-blocks, or 100-blocks are duplicated, and why?
- How are shared service numbers handled? Shared service prefixes and shared service 1000-blocks are those in which different types of service may be mixed at a lower level, such as within 100-blocks. This means that wireless numbers can exist together with landline numbers within a single prefix, 1000-block or 100-block and depending on the sample supplier's frame construction the same number might exist on both the landline frame and the cell frame (resulting in overlap) or neither frame (resulting in non-coverage).
- What levels of geography are available for sample selection and how have they been determined? County-level assignments are generally based on rate center location information for prefixes or 1000-blocks, as provided by the service providers on administrative databases. Therefore, most county-based geographies such as Census Region, Census Division, State, MSA, and DMA will be available, but sub-county geographies such as ZIP code will not be available.

[8] For example, one major sample vendor updates its frame monthly based on the latest monthly Telcordia file.
[9] One major sample vendor recommends that all these wireless services (Dedicated, Cellular, PCS and Special Billing), except Shared, be included. Shared exchanges/blocks by definition may contain landline and wireless numbers. This creates the possibility of overlap between a vendor's cell phone and landline frames. Inclusion of Shared should depend on whether or not the vendor has removed the overlap of 100-blocks or 1000-blocks between the vendor's landline RDD frame and cell phone frame. If overlap has been removed, then inclusion of Shared also is recommended. If overlap has not been dealt with, exclusion or inclusion could lead to reduction of coverage or duplication respectively.

Ported Numbers. Researchers also need to consider how they want to handle ported numbers. Number portability is the ability of users of U.S. telecommunications services to keep their existing telephone number when changing from one local service provider to another within their local exchange or rate center. The FCC has reported that as of September 30, 2009, approximately 2.5 million landline numbers in the U.S. have been ported to wireless service (FCC, 2010), which represents approximately 1 percent of all U.S. working cell phone numbers and 0.5 percent of working landline numbers (including business numbers). Landline numbers ported to wireless service will not be included in a cell phone frame. Sample suppliers normally remove landline numbers ported to wireless service from landline telephone samples since to dial such numbers, or any cell phone number, using automated telephone equipment violates FCC regulations stemming from U.S. Telephone Consumer Protection Act (FCC, 2003). This creates a gap in coverage, which may add coverage bias, since these ported numbers are not in the landline or the cell phone frame.

Sample suppliers use the Neustar Intermodal Ported TN Identification Service to identify and/or remove these ported numbers. Some researchers have obtained their own Neustar Intermodal Ported TN Identification Service license.[10] This allows them to receive and identify numbers ported to wireless service in their landline samples so that these numbers can be hand-dialed to avoid violating Federal Trade Commission (FTC) regulations. Having a Neustar license also allows firms to perform their own treatment of ported numbers in a timely (daily) manner. Once a *licensee* has identified ported numbers, those numbers may be removed from the sample or dialed using hand-dialing. (See section on Legal and Ethical Issues for further details.)

It is important to note that Neustar's Intermodal Ported TN Identification Service licenses limit the use of their data to TCPA compliance activities. In other words, the database may only be used by a licensee in their efforts to comply with TCPA regulations prohibiting calls to cell phones using automated telephone equipment and may not, for example, be used to construct or enhance a cell phone frame.

[10] This database is licensed for the "sole purposes of: (1) avoid engaging in TCPA Prohibited Conduct by verifying whether TNs [telephone numbers] are assigned to a paging service, wireless telephone service, specialized mobile radio service, or other radio common carrier service, or any service for which the called party is charged for the call; (2) disclosing, selling, assigning, leasing or otherwise providing the TN Ports to a third party that itself qualifies as a "Customer" under an Intermodal Ported TN Identification Services Agreement for the sole purpose of avoiding TCPA Prohibited Conduct by verifying whether TNs are assigned to a paging service, wireless telephone service, specialized mobile radio service, or other radio common carrier service, or any service for which the called party is charged for the call." (http://www.tcpacompliance.us/content/IntermodalUserAgreement.pdf)

Evaluating the Adequacy of the Coverage Provided by U.S. RDD Cell Phone Samples

Currently, available frames of cell phone numbers in the U.S. can provide excellent national coverage of the U.S. cell phone population. Nevertheless, many coverage issues need to be considered when designing a cell phone sample, *particularly one that is not national in scope*. Because of these coverage issues, it is even more important for cell phone general population surveys than for landline surveys to determine the geopolitical residential location of each respondent during the interview for establishing eligibility and for weighting purposes.

Recent research (Christian, 2009) suggests that in an RDD national sample of cell and landline telephone numbers, 40 percent of cell phone subscribers (and 43percent of cell phone only subscribers) do not live in the county associated with their rate center, as compared to only 8 percent of landline telephone subscribers. At the state level, such differences are less pronounced but still meaningful (i.e., of non-negligible size). Specifically, 10 percent of cell phone subscribers (and 12percent of cell phone only subscribers) do not live in the state associated with their rate center as compared to only 3 percent of landline subscribers.

There are two main reasons for the difference:

- Most wireless service areas or exchange boundaries are significantly larger than their landline equivalents, and frequently cross county borders. Also, different cell phone providers in the same rate center may have different coverage areas for their service. This means that the geography covered by cell phone Provider A in a given rate center may be smaller or larger than the geography covered by cell phone Provider B in the same rate center.
- The exchange (prefix) associated with a cell phone number represents the original point-of-purchase where the subscriber lived or worked when service was originally acquired. This may not represent where the subscriber currently lives or works. In recent years it has become more common for wireless carriers to allow subscribers to select a prefix that is not as closely tied to their residence as in the past, although it is usually within their metropolitan area.

As a result, defining the sample geography below the level of the entire nation, such as a single county or group of counties, can result in an unknown coverage error due to some or all of the following:

- It is not uncommon to live in a different county than the county in which the cell phone exchange rate center is located.
- There may be no rate centers located within one or more of the counties to be sampled.
- An unknown number of subscribers may live in a neighboring county that is not included in the sample geography.
- An unknown number of subscribers may live in a county to be sampled, but have cell phone telephone numbers in a rate center located in a county that is not being sampled.
- A number of subscribers may have a cell phone number provided by an employer that is associated with the location of that business and not with the location of the subscriber's residence.
- There are no addresses associated with cell phone numbers that can be used to accurately define exchange coverage areas.
- Subscribers can move to a different city or state and keep their cell phone telephone number. This cell phone transportability can lead to frame undercoverage due to in-migration (subscribers who have moved into a sampled area but with a cell phone number not associated with that area) and to *frame overcoverage due to out-migration* (subscribers who have a cell phone number associated with the sampled area but who currently live outside that area). Although overcoverage can be addressed by including proper screening questions in the survey instrument, more comprehensive solutions must be devised for cell phone surveying that effectively solve these coverage problems.

Integrating RDD Samples by Combining Samples from Cell and Landline Frames

Integration of cell phone and landline samples may be accomplished in several ways, and researchers should fully disclose the methods used.

To produce representative samples, telephone surveys of the general population should collect sufficient information from respondents and their sample provider to be able to construct

appropriate weights that reflect the probability of selection of each household and/or respondent. (Discussion of these issues appears in more detail in the Weighting section of this report. Examples of questionnaire items for these purposes appear in Appendix B.)

Cell phone frames and landline frames are *overlapping frames* in that individuals and households with both landline phones and cell phones will be represented on both frames. This duplication results in multiple probabilities of selection for the affected individuals/households. Since the NHIS (Blumberg and Luke, 2010) estimates that 80 percent of U.S. landline households and 83 percent of U.S. landline adults have one or more cell phones, *this significant overlap must be considered at every step of the survey design process*.

Two different sampling approaches have been used to handle situations in which a household in the U.S. can be reached by both a landline and a cell phone. *However, there is as yet no consensus on whether one of the approaches is always preferable.* This is further complicated because of the difference between whether someone can in theory be reached via a landline or cell phone (i.e., do they have one or both services?), which is a coverage issue, versus whether they can be reached in practice via either or both types of telephone services (i.e., how often, if at all, will they answer a call on a particular service they have?), which is a noncontact-related nonresponse issue.[11]

Research by Pew (2009) and Brick (2009) suggests that individuals and households with dual service often have different response propensities depending on whether they are contacted on their cell or landline phones.

To the extent that those with dual service who are more likely to agree to be surveyed when contacted on their cell phone than their landline differ in non-negligible ways on the variables of interest from those with dual service who are more likely to agree when contacted on their landline than their cell phone, error in the form of nonresponse bias will result. In general, people with dual service are thought to be more likely to cooperate with a telephone survey when sampled on the service they use most often.

[11] A person with dual service that predominantly uses a cell phone has come to be termed “wireless-mostly” or “cell phone mostly,” whereas a dual service person that predominantly uses a landline has come to be termed “landline-mostly.”

The Pew research also suggests that there are demographic differences between dual users and the other groups. These demographic and response propensity differences may lead to *differential nonresponse*, which if not accounted for can lead to biased estimates. (See further discussion in the sections on Nonresponse and on Weighting.)

The NHIS releases national estimates for the **"**wireless-mostly**"** population. Wireless-mostly (also called "cell phone mostly") respondents are defined by NHIS as respondents who receive "all or almost all calls" on their cell phone. Landline-mostly (sometimes called "wired-mostly"), as defined by NCHS, are those that receive "all or almost all" of their calls on their landline phone.[12] The two "mostly" groups are individuals or households that are covered by both frames but *may* potentially be unreachable in one or the other of those frames. During the period of July through December 2009, NHIS estimates that 26 percent of households with both landline and wireless service received "all or almost all" of their calls on their cell phone (Blumberg and Luke, 2010). These wireless-mostly adults, when compared to wireless-only adults, are more likely to be White, over 45 years of age, have a college degree or higher, have a higher income, own their residence and be related adults with no children or adults with children. Since wireless-mostly households also have landlines, if they are excluded from a screened sample because they have a landline phone it can create a possible nonresponse bias.

Thus, new research needs to be conducted to better understand the realities of response propensities associated with the "wireless-mostly" cohorts in dual frame designs and in estimating the potential response bias of landline frames. This new research includes determining the most reliable wording to use in survey questions to measure these constructs, which includes determining whether there is a non-ignorable difference between what people say they do and what they actually do vis-à-vis their phone service usage. The ultimate question is the extent to which "wireless-mostly" individuals are unreachable on their landline telephone.

Research by Boyle, Lewis, and Tefft (2009) investigated some of these issues. This research looked at response propensities from a different perspective. The authors suggest that a more accurate gauge of the likelihood of reaching a dual service individual or household on their landline could be operationalized by asking: "Thinking just about the landline home phone, not

[12] The following question wording is used by NCHS to ascertain these statuses: "Of all the telephone calls that you or your family receives, are: All or almost all calls received on cell phones; Some received on cell phones and some on regular phones; or Very few or none on cell phones?". However, Villar, Krosnick, and DeBelle (2010) call into question the validity of this wording and provide evidence that the word "personal" (as in "personal calls") is a more valid way to word the question.

your cell phone, if that phone rang, and someone was home, under normal circumstances how likely would it be answered? Would you say it is: extremely likely, very likely, somewhat likely, somewhat unlikely, or not at all likely?" They suggest that this is a more accurate estimate of the percent of the dual user population that is actually *unreachable* in a landline RDD sample. However, as noted above, there may be a discrepancy between reported intended behavior and actual behavior as well as the role Caller ID, showing the name of the incoming caller (e.g., ZYX Research), might play in any estimate.

A national dual frame survey conducted by Abt SRBI for the 2009 Traffic Safety Culture Index Survey used both sets of questions in an attempt to differentiate between "wireless-mostly" and the proportion of dual users actually not reachable on their landline. Their findings were that 16 percent of the adults were landline only, 19 percent were cell phone only, and another 16percent would be classified as "wireless-mostly" based on the NCHS questions related to usage. The results also indicated that only 4percent of adults reported that it was "somewhat unlikely" or "not at all likely" that their landline phone would be answered. However, the study found that three out of five (61 percent) of these potentially unreachable adults actually completed the survey on their landline phone.

Keeter, Dimock, and Christian (2008) took a similar tack by asking, "If I had called you just now on your landline phone, would I have been able to reach you?" They found that 45 percent of the cell phone respondents reported that they could not have been reached on their landline. Among those receiving the majority of their calls on a cell phone, this figure was 52 percent. So roughly speaking, they estimated that about half of the wireless-mostly will not be reached through the landline frame.

The question of whether heavy cell users will also respond to a survey on their landline phone was studied directly by Kennedy and Everett (2009). They conducted a repeated-measures dual frame RDD experiment in which dual users who responded to an initial survey were later randomly assigned to be interviewed for a subsequent, ostensibly independent, survey on either their landline or cell phone. Dual users originally reached through the landline frame were significantly less likely to respond to the subsequent survey if they were called on their cell phone (AAPOR RR1=39 percent) versus being called on their landline (AAPOR RR1=59 percent). By comparison, dual users originally reached through the cell frame were equally accessible for the subsequent survey on their landline (AAPOR RR1=55 percent) and on their

cell (AAPOR RR1=54 percent). These results suggest that the accessibility of the "wireless-mostly" via the landline frame is greater than the accessibility of the "landline-mostly" via the cell frame.

Although there are no national data on the "wireless-mainly" (Boyle et al., 2009) population, a number of researchers has used the estimates for the "wireless-mostly" population from the NHIS to post-stratify the overlap group of dual users into two sub-groups: "Wireless-mostly" and all others (Pew, 2009). This adjustment requires that ownership and usage information be gathered from all respondents during the interview process. Based on NHIS data for the second half of 2009 for adults (adjusted to remove adults with no phone and those with unknown cell phone status) the ownership and usage adjustment parameter would be:

- 24.5 percent Cell Only
- 58.2 percent Dual (Cell and Landline)
    - 25.7 percent All/Almost All on Cell
    - 74.3 percent Some/None on Cell
- 14.9 percent Landline Only

Further discussion of these issues is presented in the sections of this report on Nonresponse, Measurement and Weighting.

Screened Approach. This sampling approach involves conducting the interview only with respondents sampled via the cell phone frame who do *not* have a landline. This requires the exclusion of numbers from the cell phone sample that are in the overlap by *screening out* those persons with both a cell phone and a landline. With this approach, persons who have at least one household landline telephone and use at least one cell phone would be *eligible for inclusion only when sampled from the landline frame*. Only those interviewed via cell phone and without a residential landline would be counted and eligible for inclusion as cell phone only persons/households.

Although this approach removes the overlap of the dual frame and thereby makes weighting simpler, it is much more expensive to field because of the added costs associated with hand dialing the cell phone sample and the relatively low incidence associated with wireless-only status; (see further discussion in the section on Costs).

Overlap Approach. This sampling approach involves conducting the interview *regardless of the frame* from which the household or individual was sampled. That is, no households are excluded (screened out) based on their type(s) of telephone service. For respondents who can be interviewed by either landline or cell phone, an adjustment should be applied to compensate for the additional chance of selection from more than one telephone number; (see further discussion in the section on Weighting). Consequently, it will be necessary to obtain telephone status for all respondents from both frames during the interview process; (see further discussion in the section on Measurement).

It also is important to consider that research by Brick (2009) has found that cell phone surveying using the overlap approach will tend to overrepresent wireless-only (and wireless mostly/mainly) respondents in the cell phone sample. This follows from the hypothesis that wireless-only individuals are more likely to answer their cell phone and to agree to be interviewed than are wireless subscribers who also have a landline. (This bias may be reduced by adjusting for telephone ownership and/or usage.)

Both the Screened and Overlap approaches have been applied in practice. Given that the NHIS collects data about the wireless-only population along with selected demographics, the resulting estimates may be used to develop post-stratification adjustments for data obtained from a single landline frame or from a dual frame under the Screened approach. Cell-only estimates for households and adults are also available for individual states. Because the cell-only population varies by state, NCHS worked with researchers from the SHADAC to develop model-based state level estimates. However these estimates should be used with considerable caution given their (a) modeled status, (b) recency (2007 estimates) and (c) resulting large margins of error.

Sample Allocation in a Dual Frame Telephone Survey. The decision on how best to allocate sample between the cell phone and landline frames should take into account cost parameters, such as the higher cost associated with calling cell phones compared to landline phones (see further discussion in section on Costs), an estimate of eligible respondents in the respective frames, and differential response dispositions and rates for each group.

Currently, researchers in the U.S. conducting general population dual frame RDD surveys use different criteria for determining sample allocation based on these considerations and their

specific research objectives. However, most researchers have attempted to obtain approximately 20 percent to 30 percent of completed interviews from the wireless frame, and thus have calculated their initially designated sample sizes accordingly. Census region, census division, or state level estimates might be used to determine the number of completes for a given state, set of states or a county or counties within a state (cf. Fleeman et al., 2010). Regardless of the sampling approach used, it is recommended that researchers should obtain enough cell phone completions, including cell-only cases, to avoid large weights for these groups.[13]

Eligibility. Sample dispositions from 12 dual frame telephone surveys conducted by Pew between June and October 2008 suggest that contact, cooperation, and completion rates were relatively similar across the cell phone and landline frames, although these rates tended to be lower in the cell phone part of the surveys. There also were differences in the Pew surveys by individual dispositions for cell phone surveys as compared to the landline surveys, such as fewer non-residential numbers, fewer no-answer/busy outcomes, but more voice mail outcomes.

Despite the similarities in response rates in the Pew studies, they consistently found that it takes approximately 60 percent more working numbers to gain a completed interview in a cell phone sample (average of 9.5 numbers per completion) than in a landline sample (average of 6.0 numbers per completion), primarily due to so many more cell numbers being ineligible for most general population surveys, compared the rate of ineligibility within a landline sample for the same geography. This difference will add to the overall cost of conducting cell phone surveys and in determining an appropriate initially designated sample allocation of cell phone numbers.

The major contributors to the difference in ineligibility rates are as follows:

- **Respondent age** – In the 12 Pew surveys referenced above, an average of 33 percent of the cell phone respondents who were screened reported that they were less than 18 years of age. The Pew Internet & American Life Project reported that in 2008, 71 percent of teenagers had a cell phone compared to only 45 percent in 2004 and 63 percent in

[13] In deciding whether specific weights are too large, some researchers look at the ratio of smallest to largest and try to constrain them based on some cut off. In this decision there are four considerations: (a) cost, (b) variance, (c) analytic domains and (d) bias. Optimal allocation based on cost and variance may suggest a very low sampling rate for one group which in turn leads to "large weights." Furthermore, if large weights are appropriate, reducing them (e.g., by trimming) runs the risk of increasing bias. For more on this topic see Potter (1990).

2006. Given this trend, it is expected that age ineligibility will continue to be a significant factor when conducting surveys on cell phones.

- **Within sample geography** – As mentioned previously, for cell phone surveying that is less than national in scope, it will be necessary to identify and screen out ineligible respondents based on their geographic area of residence relative to the geography associated with their telephone number on the frame. This incidence (geographic eligibility rate) can vary from 94 percent for census region of residence, to 90 percent for state of residence, to only 60 percent for county of residence (Christian and Dimock, 2009). These eligibility/incidence rates may be even lower for otherwise eligible wireless-only adults, but who tend to be younger and more likely to move or have a cell phone number associated with the residence of their parents.

- **Telephone ownership** – When screening for wireless-only adults, experience continues to suggest that due to their greater proclivity to cooperate with a telephone interview on their cell phone, their incidence will be higher than would normally be expected based on their overall prevalence within the cell phone population. Although NCHS estimates that in the second half of 2009 approximately 23 percent of the U.S. adult population was wireless-only, 34 percent of cooperating cell phone respondents in the Pew surveys reported being wireless-only. In the 2007-2008 CHIS survey of Californian adults, 50 percent of cell phone respondents reported being wireless-only vs. an NHIS estimate of only 18 percent for the West Census Region (cf. Brick, 2009). Additionally, there is the possibility that an individual's personal telephone ownership status might be different depending on which adult in the household is responding for the household. Adults, for example, living with parents who have a landline phone might consider themselves as wireless-only if they do not answer the parents' landline phone. However, they technically are not wireless-only since they would be both eligible and potentially reachable in an RDD landline survey that selects a respondent from among all the adults living in the household. Issues associated with cell phone sharing discussed below may also need to be considered when determining telephone status.

- **Language spoken** – When conducting surveys only in English, a proportion of contacts may be deemed out of scope (ineligible) due to a language barrier. In 11 of the national Pew surveys, an average of 6 percent of their cell phone contacts did not speak English

versus 4 percent for the landline sample. In the one survey that was conducted in both English and Spanish (the 2009 Religion & Public Life Survey) only 0.5 percent of cell phone contacts and 2.3 percent of cooperating cell phone numbers were dispositioned as Language Barrier, about the same proportions as for the landline sample. This difference is primarily a function of the disproportionate number of minorities among the U.S. wireless-only and wireless-mostly populations – a difference that is also a factor of survey geography. The NCHS report for the second half of 2009, estimated that 30.4 percent of Hispanic adults and 20.6 percent of Asian adults are wireless-only and that 16.9 percent of Hispanic adults and 18.5 percent of Asian adults are wireless-mostly. In the 2007 California Health Interview Survey (CHIS), which was conducted only in English in California (which has a high incidence of Hispanics), 8% of the respondents contacted by cell phone did not speak English. Consequently, language barrier rates can be reduced if a cell phone survey (as well as a landline survey) is conducted in Spanish as well as English.

See sections of this report on Nonresponse, Measurement and Weighting for further discussion of these issues.

Within-Household Coverage Issues in U.S. RDD Cell Phone Samples

Cell phone samples also create sampling issues related to within-household coverage that have not been adequately addressed at the time of this report. (This is a topic area that warrants future research.)

Cell Phone Sharing. The relationship between the number of adults in a household and the number of cell phones in that same household is not always one-to-one. An individual may have more than one cell phone or may share a cell phone or cell phones with other adults or children. Currently, there is little reliable literature regarding the sharing of cell phones. National Health Interview Survey (NHIS) data suggest that one in seven wireless-only households had fewer cell phones than adults (Blumberg, 2009), which implies that at least some sharing is occurring.

In a 2007 cell phone survey conducted in three states for the Behavioral Risk Factor Surveillance System (BRFSS), data were gathered about cell phone sharing. Sharing was

defined as “sharing a cell phone one-third of the time or more with another adult in the household.” This survey found 11 percent, 15 percent, and 17 percent of respondents in the three respective states shared their phone. The authors also found that the rate of sharing was higher for adults living in wireless-only households. In the landline survey, 11 percent of respondents in households with at least one cell phone reported sharing cell phones (Link, Battaglia, Frankel, Osborne and Mokdad, 2007b). A number of researchers believe that sharing may occur more often between parents and children or between siblings within a household.

In contrast, using Gallup national surveys, Buskirk, Rao and Kaminski (2008) reported that upwards of one third of recent landline “cord cutters” (people who had become cell phone only) shared a cell phone with someone else in their household.

A recent study of mobile phone sharing in Germany (Fuchs and Busse, 2010) found that 36 percent of adults shared a mobile phone: 9 percent were “active sharers only” – respondents who answer calls on another person’s phone; 8 percent were “passive sharers only” – persons who answer calls on the respondent’s phone; and 19 percent were both “active” and “passive” sharers. “Active” sharers were more likely to be young, unemployed, single and living in multi-person high income households. People that allowed “passive” sharing tended to be single, female, lower education and unemployed. The authors also speculate that sharing may occur even with persons outside the respondent’s household.

Data from the NHIS for the second half of 2009 (Blumberg and Luke, 2010) confirm that sharing is a reality. All these data suggest that sharing, as it relates to probabilities of selection, is an activity that should be considered when designing a cell phone survey.

Business Cell Phones. Another factor that may impact within-household coverage is the presence of business phones and/or more than one personal cell phone. Do researchers need to know, and thus to ask, if the cell phone is a business phone or used as a combination business and personal phone? Under what circumstances should these conditions result in the sampled number being considered out-of-scope? The answers to these important questions are currently unknown.

Multiple Cell Phones. Many people have more than one cell phone, and thus in theory they are an increased probability of being sampled in a cell phone survey. But this, too, is a percentage

for which reliable data have not yet been reported. However, it is known from the NHIS that "wireless-only" households and "wireless-mostly" households are more likely than "landline-mostly" households to have more cell phones than individuals, which is an indication that these types of households contain at least some residents with multiple cell phones (Blumberg and Luke, 2010).

Respondent Selection: Although there is still little empirical evidence regarding the ability to interview a different adult from the one originally reached when a cell phone is shared among adults, there are at least five different methods for selecting a respondent within a household in cell phone surveys. These methods are:

1. Select the person who answers the phone, with no screening for others who possibly share the phone.
2. Select the person who is the "primary user" of the phone, with screening for the primary user.
3. Randomly select a respondent from among all the "eligible" users of the cell phone, after screening for how many eligible persons use the phone and making sure that all such persons do in fact qualify as being "eligible" to be surveyed. However, research (e.g., Brick, 2009; Lavrakas, Tompson, Benford and Fleury, 2009) suggests that response rates are lower when trying to have a "handoff" to another eligible respondent. Furthermore, since other research (e.g., Lavrakas, Tompson and Benford, 2009) suggests that approximately one-third of cell phone respondents are reached while they are away from their home, this further complicates the challenge of getting a randomly selected "someone else" who shares the cell phone to be present and actually speak with an interviewer.
4. Randomly select from among all eligible persons in a household, if this is a household study, *regardless* of whether all these people use the cell phone on other occasions, with screening for the number of eligible household members (similar to many landline within-unit selection procedures). However, this would be expected to lead to even more nonresponse by requiring the cell phone to be handed off to someone else who does not use the phone under other circumstances.
5. If this is a wireless-only household, randomly select from among all eligible persons in a household and other members of the household who share the respondent's phone or do not have their own cell phone. This too would be expected to lead to even more

nonresponse by requiring the cell phone to be handed off to someone else who does not use the phone under other circumstances.

Future research will be needed to determine which option above is superior among Methods 1, 2, and 3. Methods 4 and 5 would be chosen only when respondents are proxies for their households rather than responding on their own behalf. Methods 4 or 5 might also be appropriate when both cellular and landline numbers are included in the same survey. Also, regardless of which within-unit selection method a researcher may chose, there is no widely accepted way that can currently be recommended for actually wording the selection request for any of the methods.

Within-unit Selection and Nonresponse. As noted above, there is an additional consideration related to within-household selection. In many cell phone surveys, the person who answers the phone is chosen to be the respondent or at least is chosen from screening to determine if s/he is eligible to be interviewed. If the introduction of a cell phone survey is of shorter duration than is common in landline surveys, the interviewer will be able to start the main part of the questionnaire more quickly. This may help avoid refusals from someone reached via a cell phone that might otherwise occur because of the time it takes after initial contact to start the interview. As a consequence, procedures that strive to improve within-household coverage by not always interviewing the person who initially answers the cell phone are very likely to increase nonresponse and thereby decrease completion rates in cell phone surveys (cf. Brick, Edwards, Cervantes and Lee, 2008).

This is one of many trade-offs that researchers need to consider explicitly when deciding whether to deploy a within-unit selection when calling cell phone numbers. Of course, the same trade-off of better within-unit coverage versus greater unit nonresponse exists for landline RDD studies that select one eligible designated respondent within the household, but in most households the “handoff” to another resident of the household will be easier (i.e., more of an “everyday experience”) when the call is made to the household’s shared landline phone.

NONRESPONSE IN RDD CELL PHONE SURVEYS

One of the most problematic features of general population RDD surveys in the U.S. is their low response rates. This problem applies to both landline RDD surveys and cell phone RDD surveys.

As measured in early comparison studies, cell phone survey response rates were approximately 10 percentage points less than response rates in comparable RDD landline surveys (Steeh and Piekarski, 2008). However, evidence from more recent dual frame surveys suggests the difference has narrowed to approximately five percentage points.[14] Unfortunately, this narrowing is not due to an increase in cell phone response rates (which consistently have remained in the neighborhood of 10 percent to 20 percent), but rather, the change has come from a further decline in the RDD landline rates. Given that the emphasis in this report is on cell phones, no discussion is presented about why the trend in landline rates continues to decline, although it is hoped that the discussion on cell phone survey nonresponse will, nevertheless, shed some light on declining RDD landline rates.

Two distinct dimensions of nonresponse in cell phone surveys are addressed in this section:

- What the sources of nonresponse in RDD cell phone surveys are; and

- How the AAPOR telephone response rate formulae can be modified to account for the unique features of cell phone interviewing.

Sources of Nonresponse

The reasons for low response rates in RDD cell phone surveys involve the same essential components that account for nonresponse in RDD landline surveys – noncontact, refusals, other noninterviews and undetermined eligibility. However, these components play somewhat different roles and have somewhat different impacts on overall nonresponse in an RDD cell phone survey compared to an RDD landline survey (cf. Steeh and Piekarski, 2008).

[14] This generalization is based on the response rates for 13 dual frame surveys conducted by the Pew Research Center over the period from 2008 - 2010. All response rates were calculated using the AAPOR Response Rate 3.

Noncontacts. When considering only noncontacted numbers confirmed as working (i.e., ones that ring but never have been answered by an actual person), the empirical evidence to date suggests that they make up approximately the same proportion of final dispositions in both RDD landline and RDD cell phone surveys provided the number of call attempts is sufficiently large (more than 5) and varied in terms of time of day and day of week.

The tendency for cell phone owners to constantly carry their cell phones with them and keep them turned on all the time means that they are potentially accessible to interviewers in a much wider variety of settings and for a greater part of their waking hours than in a landline survey. In the coming years, as more people think of the cell phone as their primary phone, the noncontact component of nonresponse in RDD cell phone surveying is expected to decrease. For the same reasons, however, the noncontact component may well increase in RDD landline surveys.

Refusals. Refusals are a main source of nonresponse in RDD cell phone surveys as they are in RDD landline surveys, especially when those surveys carry out many callbacks. However, in several comparison studies of both types of RDD surveys, the refusal rate in the cell phone survey exceeded the rate in the comparable landline survey by five to 20 percentage points.

Given the structure of the telephone system in the U.S., it is easy to understand why refusals are more numerous when the mode of contact is a cell phone. Reasons for this include:

1. *The called party often is charged for a cell phone call.* Even though U.S. service providers now offer a number of different calling plans that provide varying levels of "free" minutes, many potential cell phone respondents will incur costs and so will be likely to refuse immediately when a stranger (the interviewer) contacts them. This problem is exacerbated in U.S. RDD cell phone surveying because potential respondents cannot be "warmed up" with advance mailings containing some form of remuneration as can be done with RDD landline numbers that are matched to household addresses.

2. *The variety of settings in which a cell phone owner might receive a call generates refusals.* It has been consistently reported that approximately one third of cell phone survey interviews are completed with someone who is away from her/his home (e.g.,

Lavrakas, Tompson and Benford, 2010). However, no one has reported the proportion of cell phone respondents reached away from home and thus no one has reported the response rate among those sampled via their cell phone that are reached away from home versus those reached on their cell phone while at home.

However, logic suggests that if a potential respondent is in a restaurant, driving a car, or in a place that is very noisy or crowded, the request for an interview might be met with a hasty "No" and an immediate disconnect before the interviewer even has a chance to mention the possibility of rescheduling the call.

3. *Some people treat their cell phones as a private device while others use them only occasionally*. In the past, many owners appeared to regard the cell phone as a private and personal form of communication shared only with family and close friends, if at all, and a proportion used their cell phones only for outgoing calls and essentially never received or answered incoming calls. There is empirical evidence (as well as myriad anecdotal experience) that supports this observation. In response to an open-ended question about whether they would mind being called on their cell phones by a research organization, respondents in a 2003 survey frequently mentioned invasion of privacy as a primary reason for being opposed (Steeh, 2003). As one respondent replied, "my [cell] phone is for 'personal use,' not for annoying people to call me on." Thus an interviewer's cold call may produce an immediate, flat-out refusal.

   This attitude, however, may not be as common in 2010 now that cell phones have become widespread within the adult population. Nevertheless, U.S. cellular numbers still are not listed in any public directory, attesting to the continued pervasiveness of the thinking that the cell phone provides "private" communication.

4. *It is more difficult to convert refusals when the mode of administration is a cell phone.* This is because interviewers trying a second call to a previously refusing cell phone number are likely to reach the same person who initially refused, rather than someone else within the household who may be more willing to cooperate (as often happens when conducting refusal conversions in an RDD landline survey).

Taking all of these factors into account, one is led to the conclusion that high refusal rates – and thus low response rates – will plague RDD surveys of persons in the U.S. contacted via their cell phone for the foreseeable future. However, in time the adverse reaction to an interviewer's call is anticipated to become less intense. Although U.S. service providers have begun to reduce the costs associated with receiving calls on a cell phone, movement to date in that direction has been slow. Were this rate of decreasing cost for receiving incoming calls to accelerate, refusals are likely to decline. In addition, eventually survey methodologists should be able to devise more effective refusal avoidance strategies that are better targeted at sampled cell phones owners, thereby better preventing refusals in the first moments of contact.[15]

Nevertheless, although some of the conditions that foster high refusal rates in cell phone surveys may ameliorate over time, refusals are expected to remain substantial because RDD cell phone surveys are exposed not only to unique circumstances, but also to the same negative influences that have been driving down response rates in RDD landline surveys during the past two decades.

Other Noninterviews. This component of nonresponse consists of two types of failure to achieve cooperation:

1. The intended respondent cannot physically or mentally participate in an interview, speaks a different language from the interviewer, and/or will not be available throughout the survey field period. As noted previously, empirical evidence shows that higher proportions of non-English respondents are reached in a U.S. RDD cell phone sample than in a U.S. RDD landline sample.

2. The intended respondent has other reasons for not being able to participate at the specific time(s) when an interviewer calls.

With the exception of language barriers, nonresponse due to these factors has remained low in RDD cell phone surveys and is basically equivalent to that observed in RDD landline surveys provided the level of effort includes multiple callbacks. In the future, the "other noninterview"

[15] For example, methodological changes, such as leaving a voice message on the first call if no one answers (Benford, Lavrakas, Tompson and Fleury, 2010), may help reduce refusals. See also further discussion of refusal conversion efforts in the Operational Issues section of this report.

component is expected to remain relatively constant and continue to be the smallest and least problematic component of nonresponse in U.S. RDD cell phone surveying.

Undetermined Eligibility. In both cell phone and landline RDD telephone surveys, a proportion of the selected sample ends in an ambiguous region between definitely working and definitely not working, but even when numbers can be classified as working, uncertainty often remains as to whether they are residential numbers. At the end of the field period these numbers are given a final status of "unknown" or "undetermined" eligibility.

The size of the unknown eligibility component of nonresponse is likely to be much larger in an RDD cell phone survey than in an RDD landline survey because cell phone numbers are not as easily identified as being definitely ineligible for the following reasons:

1. *The plethora of operator messages in the U.S., which differ by provider, often are unclear and confusing to interpret accurately.* As a result, it often is very difficult for an interviewer to accurately determine whether, in fact, the number is truly ineligible. Table 2 presents some examples of common operator messages that are highly ambiguous as to whether a cell phone number is working or not working.

Table 2. Examples of Ambiguous Cell Phone Operator Messages
This phone's voice mail has not been set up yet.
The number or code you dialed is incorrect. Please check the number or code and try again.
The cellular phone you have called is turned off or out of the service area; please try your call again.
This number is not accepting calls at this time.
Press 0 to speak with an operator.
Please enter the extension of the party you are trying to reach.

2. *Many business cellular numbers also are used for personal communication and this dual use makes them eligible sample units.* Since a telephone number in a general population survey must be used only for business or commercial purposes to be considered ineligible, few cell numbers will meet this standard. Distinguishing between residential and commercial numbers becomes more problematic and less reliable in RDD cell phone surveys than in RDD landline surveys. Without asking, there is no easy method for determining whether a given cell number has reached an eligible respondent on a "personal" or a "business" cell phone.

3. *Some owners do not turn their cell phones on for long periods of time.* They may turn them on only in emergencies or only when they want to make an outbound call. However, and as suggested earlier, this practice, which leaves the working status (and thus the eligibility) of a great many RDD cell phone numbers in doubt at the end of the field period, is definitely on the decline. Current data from a U.S. national study estimate that 87 percent of cell phone only and 81 percent of dual users keep their cell phones on all the time (Carley-Baxter et al., 2010).

4. *Technologies such as answering machines, voice mail, and Caller ID operate differently in cell phone and landline surveys creating uncertainty about eligibility.* In telephone surveys of the general population, household answering machines, voice mail and Caller ID are used to identify eligible landline and cell phone numbers. However, their impact on nonresponse may differ for the following reasons:

   (a) Not all landlines are attached to answering machines or have voice mail. Nearly all cell phones have voice mail. Although this may seem to give cell phones an advantage since having the interviewer leave a message when no one answers appears to increase participation (cf. Benford, Lavrakas, Tompson and Fleury, 2010), there are other factors that must be taken into account.

   (b) It is unclear whether messages left by the telephones' owners are qualitatively different on landlines versus cell phones. For example, businesses may be more likely to identify themselves clearly as businesses on a landline than on a cell phone. Given the fact that cell phones are more often used for both personal and business purposes, as noted previously, lends support to this possibility. Furthermore, on a landline there are presumably more instances for leaving a "household" message (e.g., you have reached "the Smiths") given its inherent nature as a household device rather than a personal device. Thus the content of answering machine and voice mail messages seem likely to be more effective at identifying eligible telephone numbers in landline as opposed to cell phone surveys.

   (c) Caller ID has two possible effects:

      (i) First, it can provide information about the eligibility of the number. Only about three out of five landlines have Caller ID. Landline Caller ID will display both a number *and* textual information. On cell phones, however, all non-blocked incoming calls show a number, but give no textual information, unless the incoming call is listed in the recipient's address book. This means that more information about the eligibility of the number can be gathered from Caller ID as it operates on landlines than compared to how it operates on cell phones.

(ii) Second, Caller ID provides potential respondents with advance information that may influence whether or not they answer the call. Are people more or less likely to pick up an incoming call when they see a strange number on a cell phone versus on a landline? Although the added text on the Caller ID of a landline has been found to help in raising RDD landline survey response rates, it does not appear to raise the likelihood that a contact will be made (Trussell and Lavrakas, 2005). Whatever the result, it is more likely to impact cell phone rather than landline surveys because every cell phone has Caller ID but every landline does not.

Future developments may help to reduce the unknown eligibility problem in U.S. RDD cell phone surveys. The industry is consolidating, and with fewer U.S. companies the jumble of operator messages eventually should result in clearer and more standardized wording. Furthermore, the sporadic use of cell phones should continue to decline as more individuals rely on the technology. Additional research will clarify the direction of the effects of telephone technologies on nonresponse making it easier for survey methodologists to devise effective solutions. For these reasons, the component of nonresponse due to an inability to determine a number's eligibility is expected to have less and less impact on an RDD cell phone survey's overall response rate.

Ineligibility in Cell Phone Surveys

When accurately identified and coded, ineligible cell phone numbers do not constitute a form of nonresponse and thus do not lower response rates. However, when they are inaccurately identified and/or coded, they can contribute to various types of error, including making response rates inaccurate.

The following are thought to be the most prevalent types of ineligibility encountered in cell phone surveying of the U.S. general population. Thus, it is important that researchers devise effective means of identifying these ineligible numbers and train interviewers accordingly.

Out of Geographic Area. Researchers need to consider the geographic implications of reaching a cell phone user in light of the target population that the survey is meant to represent. Geographic screening of those reached on their cell phone is necessary in all cell phone surveys that are not national in scope and do not have subnational geographic stratification in their design.

Unfortunately, geographic screening via telephone often is not easy to carry out accurately. If the wording used for the geographic screening is not well crafted by researchers and well implemented by the interviewers there will be a nonnegligible number of Errors of Omission – false negatives in which someone is *incorrectly screened out* when they are in fact geographically eligible – and Errors of Commission – false positives in which someone is *incorrectly screened in* when in fact they are geographically ineligible. Furthermore, screening may add to the number of refusals that occur during the survey introduction when such screening is likely to be carried out, especially if it is not devised to work as parsimoniously as possible.

Age Ineligible Minors. Due to the large number of persons using cell phones who are under the age of majority in the U.S. (i.e., 18 years old in most cases, although some states set the age at 19 or 21), researchers need to establish minimum age requirements for a general population survey calling cell phone numbers, *including who can serve as a household informant during the survey introduction*. Scripts and disposition codes must be devised for interviewers to use whenever a person under the age of majority is reached. Furthermore, there is anecdotal information that some minors purposely will answer age screeners inaccurately in order to participate in a survey, especially if the survey topic interests them. Researchers should anticipate this possibility in light of the frequency of reaching minors in any U.S. cell phone sample and decide what steps, if any, should be taken to try to minimize this from happening.

Purely Business Cell Phones. Clear and consistent rules for interviewers to determine when a number should be assigned an ineligible disposition of “business phone” should be established. Many persons with a company-provided cell phone use the phone to take both business-related and personal telephone calls (many, but not all, U.S. employers allow this), but they typically do not volunteer that the phone is used for business purposes unless they are asked directly. An *a priori* decision about whether such numbers should be considered as being eligible in a survey needs to be made by the researchers at the time of planning the survey, and rules should be

established for interviewers to accurately determine whether these numbers are eligible or ineligible. For example, an answer of "Anna's Cleaners" clearly identifies a cell phone used for business purposes; but whether it is used for business only and thus clearly ineligible for a general population survey remains to be determined by the interviewer.

Group Quarters. Traditionally in landline surveys, persons living in group quarters were not considered to be eligible. As cell phones have become commonplace, the affordability of cell phone service has enabled many in group quarters to have their own personal telephone which would not have been possible if it were a personal landline. Thus, survey designers need to consider whether a person reached on a cell phone in group quarters or other persons living in group quarters (e.g., dormitories, military barracks, etc.) along with a sampled cell phone owner should be made eligible sample members. If others in the group quarters are not eligible, then interviewers need to understand that it only is the person initially reached via the cell phone who is the respondent. If others in the group quarters who may also use the cell phone are eligible, then some form of systematic within-unit selection must be chosen by the researcher and deployed by the interviewer. The latter would cause the cell phone to be "handed off" to someone else in some portion of these cases, and this known to lower response rates compared to interviewing only the person who initially answers the cell phone.

The traditional rule for making anyone reached in group quarters ineligible may hold depending on the researcher's definition of an eligible housing unit. These decisions defining ineligibility should take into account the fact that it appears that a larger percentage of owners share their phones than has been originally assumed by many researchers.[16] This is especially true when an owner has more than one cell phone.

Nonresponse Bias

Although response rates for RDD cell phone samples tend to be low (and comparable or slightly lower than for parallel landline samples), this does not imply that their estimates necessarily suffer from nonresponse bias. As with landline surveys the level of bias resulting from nonresponse is different for each survey estimate. The bias will be negligible, unless there is a

[16] Fuchs and Busse (2010) have found this to be true in Germany when both "active" and "passive" sharing is measured. Their research shows that asking about whether a cell phone is shared with someone else is a more complex construct to measure than many had assumed.

relationship between the likelihood of participating and the outcome of interest – a bias persists after weighting.

Few studies to date have addressed nonresponse bias in cell phone surveys. As a consequence, *an understanding of when such relationships are likely to exist is woefully incomplete*. However, one can use findings from research studies that have investigated correlates of the propensity to cooperate in a cell phone survey and then make reasonable projections to circumstances under which nonignorable nonresponse bias may well exist in U.S. cell phone surveys.

Research has shown that people interested in technology are more likely to participate in cell phone surveys than those who are not (Brick et al., 2006). Similarly, people who use their cell phones frequently are more likely to participate than infrequent users (Brick et al., 2006). In 2009, the proportion of completed interviews with cell phone only respondents in U.S. national cell phone surveys tended to be twice (or more) as high as the estimated percentage of cell phone only adults within the general adult population. This suggests that (1) contact rates are substantially higher for cell phone only respondents compared to cell phone respondents with landlines, perhaps because they are more likely to answer unidentified calls and/or (2) refusal rates are substantially lower for cell phone only respondents than for cell phone respondents with landlines, perhaps because they are more likely to view their cell phone as a broad access point rather than a private line. This has important implications for the efficiency of sampling cell phone only adults in cell phone samples as well as for the representativeness of unweighted samples from cell phone surveys. For example, studies relying on cell phone samples to estimate levels of interest in technology (or related constructs) or cell phone usage would be expected to overestimate the parameters of interest.

Additional research is needed to identify other variable domains that are at serious risk of nonresponse bias in cell phone surveys. In particular, it would be useful to know if common correlates of response propensity in landline surveys (e.g., education, age, minority status, civic engagement) are also correlated with response propensity in cell phone surveys. This research could be conducted under different weighting protocols to determine if nonignorable bias remains after such adjustments.

Outcome Codes and Response Rates in U.S. Cell Phone Surveys

Disposition Codes Used in Cell Phone Surveys. In many instances, the disposition codes and the formulae for calculating response rates published in the AAPOR *Standard Definitions* for RDD landline surveys can be reasonably well adapted to be applied to RDD cell phone surveys. Some differences lie in the interim (temporary) codes assigned prior to the final disposition and are due to the nature of the call to a cell phone. Other differences are due to new outcome codes that are only possible with cell phone surveys, to current AAPOR landline codes that change in meaning or prevalence when processing RDD cell phone samples, and to codes that apply only to landline surveying and can be eliminated altogether for cell phone surveys (cf. Callegaro, Steeh, Buskirk, Vehovar, Kuusela and Piekarski, 2007; Barron, Khare and Zhen, 2008).

1. *New interim codes.* In calls to cell phones, possible new interim codes include "respondent not reachable at this moment" or when a "network busy" message is encountered. When the field period for a cell phone sample is closed, codes such as these that are still in their interim status must be classified into a final disposition status.

   Other new disposition codes are required for the situations that do not arise in landline surveys. For example, unlike a landline, a cell phone can be in a geographic area (i.e., depending on the comprehensiveness of the service provider's geographic coverage) or other location without service coverage (e.g., inside a tunnel; in the basement of a parking garage; etc.). Cell phones also are switched off more often than landline ringers are turned off within a household. Usually in these cell phone instances an operator message or a voice mail message will allow interviewers to classify the outcome into new disposition codes that account for these circumstances (e.g., "not in service at this time"). Although this cell phone survey outcome may appear to be the close equivalent to a "disconnected" or "not working" outcome in a landline survey, its implication is quite different in the cell phone survey. In the landline survey this outcome likely will be a final disposition indicating a number that is ineligible for a completion. In contrast, in a cell phone survey, the disposition is an interim one and the number should be redialed as often as the calling rules for the sample allow in an attempt to reach someone when the phone is turned back on or comes back into a geographic area or location in which its service is working.

Another situation that does not arise in landline surveys stems from the fact that people may be doing almost anything when they answer their cell phone — walking in a crowded place, driving a car, visiting a restroom, flying in a helicopter, attending a basketball game, eating in a noisy restaurant, etc. (cf. Richtel, 2010). The use of new interim disposition codes that identify these outcomes would help researchers determine how large an effect this "temporary unavailability" has on the processing of cell phone samples.

2. *Codes with different meanings in cell phone surveys compared to their meaning in landline surveys.* When calling cell phones, some landline disposition codes may have different or expanded meanings. The "breakoff" code in landline surveys is a case in point. It indicates that the landline respondent herself/himself actively has terminated the interview prematurely. In a cell phone survey, on the other hand, a "breakoff" may also occur as the result of a dropped call or other technical problems and may have nothing to do with the respondent actively deciding to break off from the interview. These kinds of new meanings should be recognized as new interim disposition codes in cell phone surveys – i.e., cases that need different handling than traditional breakoff refusals in landline surveying.

3. *Codes with different prevalence in cell phone vs. landline surveys.* The Household Level Refusal code (i.e., a refusal that occurs *before* a designated respondent has been selected) is an example of a code that has a markedly different prevalence in cell phone surveys. Due to the personal nature of most cell phones in the U.S., a refusal by somebody other than the designated respondent is much less likely to occur in cell phone surveys than in landline surveys. Other examples of codes that arise less often in cell phone surveys include fax machine and busy signals.

4. *Landline codes not applicable in cell phone surveys.* The codes in landline surveys that are often not applicable in a cell phone survey include other household level codes, such as group quarters and household level language problems provided the designated respondent is the person who answered the phone.

5. *Ineligible codes and cell phone survey response rates.* The AAPOR *Standard Definitions* guidelines make note of a number of differences in calculating response rates within a cell frame compared to a landline frame (AAPOR, 2009):

   (a) Although in most general population landline surveys researchers can reasonably assume that almost all sample records that are deemed to be a household are eligible to be interviewed, researchers cannot as readily assume eligibility status in cell phone samples because of:

      (i) the geographic area of a specific target population;

      (ii) required screening of specific cell phone users such as those that are cell-only and cell-mostly; and/or

      (iii) the likelihood that the cell phone is owned/used by someone under the age of 18 (in studies that must select an adult member of a household ages 18 and older).

   In all three of these cases, researchers should only include persons screened as eligible into Category 2 of AAPOR response rate calculations, per the AAPOR *Standard Definitions*.

   (b) In studies that *only* sample cell phones, it is proper to treat numbers that have been ported to a landline as ineligible for the survey (code 4.46, landline).

   (c) Cell phones are more likely to reach owners who are ineligible for many general population surveys, e.g., college students living in dorms, foreign visitors staying in hotels, or day laborers living outside the United States.

6. *Special considerations in calculating response rates for cell phone sample dual frame surveys.* In calculating a single response rate for a dual frame survey, *it is necessary first to calculate separate response rates for the individual frames*. In doing this, there are two issues that should be taken into account in calculating the cell phone rate that do not apply to the landline rate.

First, operator messages tend to be less standardized for cell phones than for landline telephones and vary by company. Some of them are ambiguous or unclear, and thus open to differing interpretations (as shown in Table 2). If this problem is not resolved, the number of unknown eligible cases will remain higher than in a comparable landline survey.

Second, at present it is unclear how the Unknown Eligibility category of nonresponse should be adjusted in Formulae 3 and 4 of the AAPOR *Standard Definitions* when the mode of administration is a cell phone. How the component, "*e*" (the estimated proportion of cases of unknown eligibility that are treated as eligible), is defined will have important effects upon response rates. Thus researchers are reminded that if they used these formulae (i.e., 3 and 4), it is incumbent upon them to explicitly disclose the basis on which they formed their estimates of *e*.

Because of these and other differences between outcome dispositions in landline and cell phone surveying, considerable caution should be exercised whenever rates for single frame cell phone surveys are compared to response rates for landline surveys.

Examples of Calculating Response Rates for Dual Frame Surveys. In dual frame designs, the rates for the units that are sampled from each frame should be combined using weights that are proportional to each segment of the population sampled from the respective frame.

To illustrate this, two examples of dual frame telephone surveys are considered below.

- *Example 1: Cell Phone Only Sample and Landline Sample.* Suppose a sample of landline telephone numbers is selected from the landline frame and a sample of cell phone numbers is selected from the cell phone frame and screened so that interviewing is done only for the cell-only households. The rates for each of these samples should be computed as noted above for the appropriate single frame design. Special care should be taken to examine the eligibility rate of cell-only households from that frame. Suppose the landline population accounts for 70 percent of the total population and the cell-only population accounts for the remaining 30 percent. In this case, the weighted overall response rate is the sum of 0.7 times the landline response rate and 0.3 times the cell-only response rate. Notice that in this case the weighting factors 0.7 and 0.3 are based

on the proportions of the population that are used in the estimates rather than the proportions covered by the frames.

- *Example 2: Cell Phone Sample and Landline Sample with Overlap.* Suppose all otherwise eligible cell phone respondents are interviewed (i.e. no screening for cell-only or cell-mostly status). In this case, households with *both* landlines and cell phones can be reached by either device and thus are called "the overlap." Also assume it is not possible to identify in advance whether a telephone number from either frame is in the overlap. Assume the landline frame covers 70 percent of the population and the cell frame covers 80 percent, with 30 percent cell only and 50 percent in the overlap. First, compute the proportion of the population sampled from the landline frame as 0.2 (landline only) + 0.5/2.0 (half the overlap) which equals 0.45; for the cell frame it is 0.3 (cell-only) + 0.5/2.0 (half the overlap) which equals 0.55. In this example, the weighted overall response rate is the sum of 0.45 times the landline response rate and 0.55 times the cell frame response rate.

MEASUREMENT IN RDD CELL PHONE SURVEYS

Cell phone surveys present special challenges not only in sampling, nonresponse, weighting, and administration, but also in measurement. The measurement challenges are primarily twofold:

- The unique nature of the cell phone may affect the behavior of the respondent and the interaction between interviewer and respondent, and this may have an impact on data quality, e.g., on item nonresponse, variance and bias.

- Additional survey items are required in both cell phone and landline questionnaires in dual frame surveys to provide necessary data for weighting and other key analyses. (This issue is addressed in the following section of this report on Weighting.)

Since AAPOR's 2008 Cell Phone Task Force report was issued, more research on the topic of data quality in cell phone surveys has appeared. Most of these studies have found little difference in data quality between landline and cell phone interviews, after controlling for the kinds of people most likely to be interviewed via each device. The only randomized controlled experiment with so-called "dual users" that has been reported to date found few systematic differences in data quality. Nevertheless there are many potential reasons to suspect that the data quality of cell phone interviewing might be lower than in landline interviews. Until more research is conducted with larger samples that are not undermined by the effects of nonignorable nonresponse – especially research that uses an experimental design – researchers are urged to be vigilant in monitoring data quality from their cell phone interviews.

Reasons for Concern about Cell Phone Data Quality

Concerns about the quality of data gathered via cell phone interviewing relative to landline interviewing arise from several sources, including audio quality, the location of the cell phone respondents during the interview, and the other activities in which a cell phone respondent may be engaged during the interview.

Sensitive topics. There long has been concern that data quality from cell phone interviews might be lower than among comparable landline interviews (cf. Lavrakas, Steeh, Shuttles and Fienberg, 2007) if sensitive data are being gathered. The reasons for this concern are straightforward. Even though many cell phone users seem perfectly willing to carry on personal conversations in public places, some people might consciously or unconsciously limit the candor or openness, and thus the accuracy of their responses may be jeopardized relative to the sensitivity of the research questions. An example of this would be a person on a crowded bus answering questions via a cell phone for a study on sexually transmitted diseases or race-related attitudes or financial investments and income, or other very sensitive topics, who may answer those questions differently than if s/he were in a more private location (e.g., her/his own home).

Multitasking, distraction, cognitive complexity and respondent burden. New behavioral research has suggested that speaking on a cell phone is a more cognitively complex task than originally thought (cf. Richtel, 2010). A possible reason for this is that conversations on a cell phone often require usage of not only one's audio senses, but also one's visual senses. This will especially be the case if one is moving (e.g., walking or driving) while speaking on a cell phone (cf. Parker, 2009). Another possible reason is that using a cell phone may allow people to engage in a wider range of multitasking activities than when using a landline, especially when away from their home. This in turn may cause the person on the cell phone to pay less attention to any one particular task (e.g., responding to a survey) compared to the other task(s) in which s/he also is engaged. As such, depending on what else people may be doing while they are being interviewed on a cell phone, they may be less likely to provide accurate data on cognitively demanding questions that require a greater than average use of one's memory and/or other advanced thinking processes.

Audio quality. Also important, the volume and quality of voices on cell phones may make it difficult for respondents (especially those with hearing difficulties) to clearly hear and comprehend all questions, and for interviewers to clearly hear and comprehend all answers, especially when respondents are reached in either noisy locations and/or places with a poor cellular transmission signal.

Rushing to complete the conversation and breakoffs. Low sound quality coupled with high potential for distraction might also cause cell phone interviews to take longer than comparable

landline interviews. Alternatively, concerns about cost and inconvenience might lead some respondents to hurry through the interview, which could mean that they do not consider their responses as carefully as they would if they were on a landline. Distractions related to being interviewed outside of the home and timing concerns also might lead to higher levels of breakoffs or interrupted interviews, both of which can have negative effects on data quality.

Existing Research on Cell Phone Data Quality

Despite these potential concerns, the growing body of research suggests that there is little difference in data quality between cell phone and landline interviews for many types of questioning. Most of this research entails comparisons of respondents interviewed by cell phone and those interviewed by landline in the same study. Because there are demographic differences in the kinds of people most likely to complete a survey by cell phone or by landline (e.g., a greater percentage of cell phone respondents are young, male, nonwhite, and/or renters), some apparent differences in data quality may be spurious, if factors such as these are not controlled. Most of the research reviewed for this report attempted to control for differences in the composition of the cell phone and landline samples.

The strongest evidence to date is from Kennedy's (2010) experiment, which randomly assigned dual-user respondents from an initial interview (those who have both a cell phone and a landline) to a follow-up interview on either a cell phone or a landline. Respondents did not know that there was an experiment being carried out and that the effect of the type of telephone service (cell phone or landline) they were contacted on was being studied. This research somewhat confirms previous findings and yet it cautions against overgeneralizing. With respect to cognitive shortcuts – those adopted by respondents to avoid having to think through alternatives or search memory for appropriate responses – four of seven tests yielded no differences between cell phone and landline respondents, two yielded weak effects suggesting lower data quality on cell phones, and one produced clear evidence of short-cutting by cell phone respondents, which is a potentially serious quality issue. Furthermore, in terms of substantive responses, Kennedy found that when cell phone respondents were interviewed away from home, they rated their social lives as significantly better than when the same respondents were interviewed at home, and rated the condition of roads as significantly worse. Since there is no objective way to determine which responses are more accurate, it is

impossible to characterize one mode or the other as more susceptible to measurement bias on these topics. Other than these intriguing results, no other comparisons in the study yielded significant differences in data quality. Even the respondents' assessments of audio quality did not differ significantly between the cell phone and landline interviews. Overall, Kennedy's research suggests that although differences in data quality between landline and cell phone interviews may exist, they often tend to be modest in size and somewhat limited in scope. (However, the sample sizes in this first experimental study on cell phone vs. landline data quality were not large and thus the reader is cautioned not to overinterpret these findings.)

Other recent research produced similar results on various measurement dimensions:

- Witt, ZuWallack and Conrey (2009) found little mode difference between cell and landline interviewing in item nonresponse or richness of response to open-ended questions, even after controlling for demographic variables.

- In a large national dual frame study, Brick et al. (2006) found no differences in terms of missing data, in the length of open-ended responses, or in responses to four sensitive questions among those who were interviewed using their cell phone compared to those interviewed via their landline.

- The Pew Research Center's 2006 study found no significant differences between cell phone and landline interviews in interviewer assessments of whether respondents were distracted or doing other things while also responding to the interview (Pew, 2006); there also were no significant differences in levels of item nonresponse.

- Kennedy's (2007) analysis of response order effects and straight-lining in dual frame studies conducted by the Pew Research Center also found no conclusive evidence of measurement quality differences between landline and cell phone samples. However, there were some marginally significant findings associated with a *recency effect* when cell phone respondents were read a list of candidates compared to landline respondents hearing the same list. This trend was particularly associated with cell phone respondents aged 40 years and older.

- Earlier research on data quality by Steeh (2004) found few differences between cell phone and landline interviews in the amount of item nonresponse, strength of theoretically meaningful correlations among items, and overall distributions when demographic differences between the samples were controlled. The data provided by respondents using cell phones did not significantly differ from those of respondents using landline phones, when comparing the same demographic groups, such as within age and race cohorts.

- Similarly, research conducted in the last decade by Statistics Sweden (Kuusela, Callegaro Vehovar, 2007) did not show any significant difference in data quality when comparing interviews done on a landline to interviews done on a cell phone.

However, a 2010 study using data from nine large national surveys and focused solely on cell phone respondents addressed the questions of whether (a) those interviewed at home versus elsewhere and (b) those interviewed while engaging in potentially distracting other behavior (e.g., driving, talking to someone else, reading, writing, playing game, texting, working on a computer, etc.) versus those not engaged in any distracting other behavior differed in the quality of responses (Lavrakas, Tompson and Benford 2010). Similar to results reported by Kennedy (2009) and Brick (2007), they found that one third (32 percent) of cell phone respondents were interviewed away from their homes, confirming that a majority of cell phone interviews take place in locations similar to those of landline interviews, thereby lessening the opportunity for outside distractions and other influences on data quality. They also found that one-sixth (16 percent) of cell phone respondents were engaged in what was judged to be a highly distracting other behavior while being interviewed.

Although total item nonresponse and item nonresponse to sensitive questions were higher among cell phone respondents interviewed away from home, neither difference was significant when tested in a multivariate analysis controlling for other variables. This study also found no differences in the strength of theoretically meaningful correlations depending on whether a cell phone respondent was interviewed at home or elsewhere. Nor was there any difference in the prevalence of “straight-lining” (i.e., the lack of variance) when asked a series of questions using a similar response format (e.g., as is done with many multi-item scales) and whether the interviewee was at home or elsewhere.

In terms of the data quality gathered from cell phone respondents engaged in at least one highly distracting other behavior while they were being interviewed, there were no significant effects associated with total amount of nonresponse, the amount of theoretically meaningful correlations or the prevalence of straight-lining. However there was a marginally significant greater amount of item nonresponse to sensitive questions among the cell phone respondents engaged in distracting other behaviors while being interviewed.

Few Differences in Data Quality, but a Cautious Approach Should Continue to Prevail

In sum, most of the empirical evidence to date regarding cell phone respondents does not support the broad assumption of poorer data quality. That is, there is no evidence to suggest that all or even most data gathered by cell phone are of poorer quality than their landline counterpart would be.

However, the reader is cautioned that "few significant differences" do not necessarily imply equivalence in data quality as there is evidence to suggest that under certain circumstances, including when asking certain types of questions, concerns about cell phone data quality are not unfounded. But data quality remains an understudied area in the cell phone survey literature. Kennedy's (2010) study is the first reported randomized experiment to study the issue of cell phone data quality, and even that study is somewhat limited due to its relatively small sample size.

Much more research is needed on cell phone survey data quality, including more research into the possible effects of *respondent multitasking* while participating in a cell phone interview. In the meantime, it is prudent for researchers to train their interviewers to be alert to whether a respondent on a cell phone is in an environment and/or is engaging in other activities that are not likely to be conducive to providing full and accurate answers to the questions the interviewer is asking. (See the Operational Issues section of this report for more discussion of this topic.)

Furthermore, as part of this cautionary approach to more fully understanding possible measurement errors in cell phone surveys, researchers are encouraged to at least ask cell phone respondents whether or not they have been reached at home and possibly about other activities they may be involved in while doing the interview. This would advance knowledge in

the field about whether data quality differences may be associated with the in-home/out-of-home dichotomy and/or with multitasking.

At the same time, it is important to note that most landline surveys do not include measures of the degree of privacy or the amount of distractions under which landline interviews are conducted, so concerns about data quality in cell phone interviews should be considered as a special issue within the broader concern of data quality in all telephone surveying.

WEIGHTING IN RDD CELL PHONE SURVEYS

Very often weights are needed in the analysis of RDD telephone surveys. Reasons that weighting is required include (1) differential probabilities of selection, (2) differential propensities to respond, and (3) sampling frame coverage problems among various groups in the population.

The emergence of households that have residents with cell phone service, but no landline service (i.e., the cell-only population) affects the way weights are constructed for RDD telephone surveys in the U.S. that sample cell phone numbers. Researchers have also recognized two other types of households that affect weighting: (1) the cell-mostly/mainly and (2) the landline-mostly/mainly households.[17] As previously noted, whereas each of these groups has both cell and landline service, it has been observed that the cell-mostly/mainly have a greater propensity to respond if called on a cell phone and the landline-mostly/mainly have a greater propensity to respond if called on a landline.

Currently, weighting that accounts for cell phones is mostly done for surveys that use two sampling frames to obtain coverage of the cell-only population. However, there remain the possibilities of surveys for which the sampling frame is made up only of cell phone numbers, and surveys conducted with landline sampling frames where the sample is weighted to a target population that includes (at least in theory) the cell-only population. In addition, some surveys have used Address Based Sampling (ABS) to obtain coverage of the cell-only population. Surveys that use ABS frames present weighting issues different from those encountered in RDD surveys and are not addressed in these guidelines. (See Appendix A for more information about ABS.)

In the remainder of this section considerations related to weighting are discussed. As was the case of the first AAPOR Cell Phone Task Force report in 2008, the discussion below applies specifically to surveys where:

- The samples for the survey are selected from RDD landline sampling frames, and/or from RDD cell phone frames; *and*

[17] Of note, important subgroups may later be identified within each of these groups.

- The population being studied comprises households, units within the household such as families, or members of households.

Although single frame designs may be employed, the main focus of these guidelines is on general population telephone surveys that are currently more common – those that sample both from landline and from cell RDD sampling frames.

Despite the fact that much remains to be learned about how to weight data obtained from cell phone household surveys, some important considerations have been identified. Two such considerations that greatly affect decisions about weighting are:

- **Geography** – is the study national in scope, multi-state (e.g. a census region), for a single state, or for an area within a state (county, city, etc.)? A study may be concerned with multiple levels; a national survey may also require regional estimates or a statewide survey may also require estimates at the city or county level.

- **Dual service users** – for a dual frame survey, whether those households/persons with both cell and landline service are accepted from either sampling frame, or whether dual users are screened out from one frame (e.g., dual users identified on the cell phone sampling frame are screened out and only the cell-only group is screened in).

Initial Questions About Weighting RDD Cell Phone Samples

Those planning RDD telephone surveys in the U.S. that will include cell phone numbers in the sample, as well as researchers planning to analyze data from such surveys, should ask (and answer to their own satisfaction) a number of questions, including:

- Are weights needed?

- If weights are required, how should the approach to weighting differ for different sample designs?

- If weights are constructed, what steps are needed?

- If post-stratification is part of the weighting, what variables should be used?

- If weights are to be used, what data does the questionnaire need to gather to facilitate weighting? What other data may need to be collected from secondary sources?

- What other issues must be dealt with in weighting?

What follows is a discussion of these questions to try to aid researchers in making informed decisions.

Factors Affecting Answers to These Questions

Answers to the above questions depend on the population being studied (defined by telephone usage, geography or both) and on the sample design used. These considerations apply when the study population comprises households, families, other subunits within a household, persons living in households or subsets of those populations.

The U.S. household population can be divided into at least four groups based on telephone service:

1. No telephone service,

2. Landline service only,

3. Cell service only, or

4. Both landline and cell service.

The first group is currently very small. The last group may be divided further into (a) those who mostly rely on their cell phones and (b) those who rely mostly on their landline phones. The target population may include all or only a subset of these groups. In addition to telephone

service and/or usage, the population may be defined by its location; it may include the entire U.S., a subset of states, a single state, one or more counties or some smaller geopolitical unit.

Four different sampling designs that affect the approach to weighting include two dual frame and two single frame designs:

- **Nonoverlapping dual frame design:** Samples are selected for the survey from landline and cell phone RDD frames, but screening is done so that any member of the target population has a nonzero probability of selection *from only one of the frames*.

- **Overlapping dual frame design:** Independent samples that are selected from RDD frames that overlap in their coverage (e.g., a landline frame and a cell phone frame) and there is no screening; thus some members of the study population (e.g., those with both cell and landline service) have a *nonzero probability of selection from more than one frame*.

- **Landline frame:** Studies in which only a landline RDD frame is used, but weighting adjustments are desired to account for the fact that the frame excludes the cell-only group.

- **Cell phone frame:** Studies in which the sample is selected only from a cell phone RDD frame, but weighting adjustments may be desired to account for the fact that the frame excludes the landline-only group.

In addition to other weighting adjustments for these four designs, it may be desirable to adjust to account for those with no telephone service.

The remainder of this section on Weighting will focus primarily on the two dual frame designs since in 2010 they are the designs most commonly used in telephone surveys of the general population in the United States. The examples given focus on two variations within each design: one where households are sampled and the other where adults are sampled within households.

When Are Weights Required?

Weights would almost always be required if both cell and landline RDD frames are used, especially if respondents having both types of service are interviewed from both frames (i.e., the dual frame without screening design).

However, there are a few instances when it may be permissible not to use weights. For example, weights might not be needed in a sample that uses only one frame and no attempt is made to generalize about those who could only be contacted via the other frame. But even in these surveys, weights usually should be constructed if there are non-ignorable differences in the probabilities of selection or if there is differential nonresponse across various groups of the population.

Another occasion when weights may not be required arises when a new mode of survey administration – one that arises from advances in telecommunication technology – is being used. In this case, comparing *unweighted* data across the old and new modes becomes a logical first step in determining how findings may differ and whether or not weighting methods, particularly for post-stratification, need to be substantially revised.

The Need for Disclosure of Weighting Procedures. The survey research community of scholars and practitioners is still in a period of uncertainty and experimentation in surveying cell phone numbers in the U.S. Thus, it remains vitally important for researchers to clearly describe (disclose) how they constructed any weights used in their analyses or to describe the basis on which they decided not to weight, if that was their decision. Thus by comparing results across studies that use different weighting procedures, the survey research community can begin to determine which procedures most effectively adjust for the kinds of errors that occur inevitably during the survey process but that can be addressed by weighting.

Steps in Weighting Process for Different Types of RDD Sample Designs

For each sample design that follows, a discussion is provided on the steps that would typically be used to weight the data. Single frame designs are covered for completeness but most attention is given to dual frame designs, overlapping and nonoverlapping dual frame designs.

Overlapping dual frame designs typically require the use of *compositing weight adjustment* factors when the samples from the two frames are combined in order to account for the adults/households that can be sampled through either frame. Two basic types of designs are illustrated: (1) a sample design that randomly selects one adult from the household, and (2) a sample of households (also covers a sample of family households, a sample of unrelated individual households, a sample of households with a specific characteristic, etc.).

The random selection of one adult from a landline RDD sample is a widely used approach. For a cell phone sample three approaches can be considered:

1. Treat the cell phone as a personal-use device,

2. Allow for sharing of a single cell phone by two or more adults in the household, and

3. Treat the sample cell phone number similar to a landline telephone number and randomly select one adult from among all adults in the household.

To date, the third approach is not often used in the U.S. and we concentrate on the first two approaches. However this may change and researchers should monitor future developments.

For a sample of households one must account for the linkages or associations between the household and the landline and cell phone telephone numbers that can be used to reach that household. In other words, within the cell phone frame a household may contain more than one personal-use adult cell telephone number and within the landline frame a household may have more than one voice-use landline telephone number. Finally, a discussion of weighting national versus state and local samples is also provided.

Weighting for Single Frame Designs. Consider, for example, a survey using only an RDD cell phone frame that does not seek to make inferences about adults not having cell phone service. For this survey, one would weight to reflect any differences in the probability of selection of sample telephone numbers. The cell phone is either treated as a personal communication device or one adult is randomly selected from the adults in the household that share the cell phone. If one adult sharing the cell phone is selected then this needs to be accounted for in the weight calculations. Ratio adjustments to account for unit nonresponse can also be considered.

For a national sample of adults one could post-stratify to population control totals from the latest NHIS public-use data file for adults living in households with cell phones. The weighting steps would be similar if one had a national sample of cell-only adults. For a sample of households one needs to add a step in the weighting process to account for the number of personal-use adult cell telephone numbers in the household.

Overlapping Dual Frame Design. A design that employs both the cell phone and landline frames without any screening presents more difficulty in weighting. So-called "overlap designs," such as these, can be used for various units of analysis: adults, or children living in households, households themselves or some combination. Weighting for overlap designs must account for the fact that some of the adults/individuals had a chance of selection from both the cell and landline frames.

Landline frame adjustments. Weighting adjustments for the landline frame have three components: (1) phone selection probability (measured from the sampling frame), (2) number of voice-use landlines (measured via the questionnaire); and (3) for the random selection of one adult from the household, a within-household selection probability (measured via the questionnaire).

Cell phone frame adjustments. For the cell phone sample the weighting adjustment to account for differential selection probabilities depends on the sampling strategy used. If the cell phone number that is called is linked to only one adult (e.g. the adult who owns or is the main user of that number) the adjustments will differ from instances where that number is linked to multiple adults (e.g., the entire household or those adults who share that phone). The cell phone sample weighting adjustments can include:

- Phone number selection probability (measured from the sampling frame);
- For adults, the number of cell phones that can be linked to each sampled adult (measured via the questionnaire);
- For households, the number of personal-use adult cell phones attached to the household, e.g., the number of cell phones for all adults in household (measured via the questionnaire); and if sampling from multiple adults linked to a cell phone, the within cell-phone selection probability of the adult (measured via the questionnaire).

The number of cell phones that can be linked to a person within the same household may be different for children than for adults. Although this adjustment depends on the sampling design, it may be the number of cell phones owned (or shared) by an adult, whereas for a child – if the survey is including minors as respondents – in the same household it may include the number of cell phones for each guardian who can grant permission and provide access to the child (or speak for the child if serving as a proxy).

Many, perhaps most, recent cell phone survey designs in the U.S. appear to assume the linkage of a cell phone to one and only one adult. It is easy to understand why this is appealing. However, one phone could be shared by multiple people and some surveys have selected from those sharing a cell phone. Multiple people could share multiple phones with multiple different people (cf. Fuchs and Busse, 2010). In the U.S., this is assumed to be rare and would be very burdensome to measure if there is a complex weave of multi-person cell phone usage. (See Best and Hugick (2010) and Wolter, Smith and Blumberg (in press) for a discussion of the linkage between telephone numbers and the individuals in the household.)

Nonresponse adjustments (i.e., weighting for nonresponse) in an overlap design should take into account differential response *between and within* the frames. First, there may be differential response between the cell phone and landline frames. In addition, there may be differential response within either frame between various types of telephone users. For example, as noted previously, the cell-mainly group has been observed to be more likely than the landline-mainly group to respond when contacted through the cell phone frame; and the reverse appears to be the case for the landline-mainly group. In addition, within the cell phone frame in an overlap design, cell-only users consistently have been found to be more likely to respond than the dual phone users.

Combining Samples Where There is Overlap. To combine the samples, researchers need items included in the questionnaire for telephone group classification. These questions should determine whether the respondent could have been selected in the other frame. In a dual frame with overlap design, the weight adjustments for probabilities of selection and nonresponse will likely need to be checked and adjusted to fit external estimates by telephone usage and demographics. Post-stratification methods can be used for groups where there are external data

sources. However, depending on the geography of the survey, external estimates of phone usage groups may be unavailable or of low quality (i.e., poor reliability).

Observations for those who have a chance of selection from both frames (i.e., dual users) may be combined by the use of composite weights. One aspect of overlapping dual frame telephone samples that has received considerable discussion is the use of composite weights for the dual users from the landline sample and the cell phone sample (cf. Hartley, 1962; 1974). In combining the dual user samples, one typically selects two compositing factors that sum to one. Many researchers currently are setting the two compositing factors to 0.5. Another approach involves calculating the effective sample sizes for the two dual user samples, and then using the effective sample sizes to determine the compositing factors. Brick et al. (forthcoming) discuss the use of compositing factors equal to 0.5 and propose an alternative approach to calculating the compositing factors based on inferring the dual user response rate in each of the two samples based on external information, typically from the NHIS. Regardless of the choice of the compositing factors, the researcher should make an effort to assemble *control totals*[18] of landline-only, dual user, and cell-only adults/households, etc., for use in post-stratification or raking (along with socio-demographic variables such as age, gender, education, etc.). For state and sub-state surveys where the control totals may not be accurate, the researcher should consider conducting a *sensitivity analysis*[19] to assess the impact of the survey estimates arising from errors in the control totals for the geographic area.

Once the weighted respondents from each frame have been merged together, a second stage of weights, known as sample balancing or raking, are usually applied to balance the sample to selected population or household demographic parameters. To help compensate for differential response/nonresponse between the two frames, some researchers include a telephone status and usage parameter in addition to their standard socio-demographic adjustments.

Non-Overlapping Dual Frame Design. A dual frame survey with screening for cell-only adults or households eliminates overlaps and the weighting process is somewhat simpler. Typically, an RDD landline frame is used to interview the landline-only group and those with both types of

[18] External population estimates for the survey target population, referred to as control totals, may be available from a previous census, the American Community Survey, the National Health Interview Survey, etc. If the sample can be divided into subgroups, for example, age by gender, and external control totals are available for the subgroups, then the sample in each subgroup can be weighted to the population total for that subgroup.
[19] See Battaglia, Eisenhower, Immerwahr and Konty (2010).

service (i.e., the dual users), and an RDD cell phone frame is screened and those with only a cell phone (i.e., no landline service) are interviewed.

For weighting and estimation purposes, this design can be considered a *stratified sample*. The study defines three nonoverlapping telephone usage groups (strata) for households or adults:

- Landline only;
- Landline and cell (or dual users which include cell-mainly and landline-mainly; and
- Cell only.

In weighting, the researchers perform design weight calculations for the landline sample and for the cell phone sample, and then combine them. The weighting of the landline sample must account for differential nonresponse by telephone usage group (including dual cell phone mostly/mainly versus dual landline mostly/mainly). In this type of design, *dual users are included only if they are reached via the landline frame*, and among these, evidence to date suggests that cell phone mostly/mainly users will be underrepresented.

For its part, weighting for differential nonresponse by telephone usage group is affected by the two different cell samples (i.e., the cell phone only group and the screened out dual service group). Different weighting procedures for the combined sample depend on whether control totals by telephone usage group are available. When they are not, raking/post-stratification to socio-demographic control totals may be the only approach available. When control totals by telephone usage group are available, the cell phone and landline samples can be adjusted to the appropriate totals, but raking/post-stratification to socio-demographic control totals may still be needed.

For this type of design as with others, the approach to weighting will be affected by the choice of sampling, reporting and analysis of units. Telephone surveys may sample individuals, or may use a “most knowledgeable” respondent to provide information about the household and its members. For a sample of households one needs to account for the number of voice-use landline telephone numbers in the household and the number of personal-use adult cell telephone numbers in the household.

Variance Estimation in Single Frame VersusDual Frame Designs. Of note, variance estimation for dual frame sample designs is somewhat more complex than for single frame designs. Thus, the Task Force suggests researchers work with a survey statistician who has experience with variance estimation for complex sample designs.

Considerations for National and State/Local Surveys

The procedures for weighting national and state/local surveys in the U.S. share many similarities, but there are two issues that may result in notable differences. The first is related to geographic eligibility and the second to accuracy and availability of control totals by telephone status and usage. Both of these issues are discussed briefly.

Geographic eligibility refers to whether the respondent lives within the geographic boundaries of the target population. For national surveys, respondents are all geographically eligible since essentially all sampled cell phone numbers (and landline numbers) are residents of the United States.

At the state/local level, the picture is very different especially for cell phone numbers that are not associated with local geographies even to the extent that landline numbers are – a situation due in part to the portability and interoperability across state/local boundaries of cell phones. As a result, some geographically eligible numbers are not sampled (resulting in undercoverage) and some sampled numbers reach persons residing in households outside the target geography (resulting in overcoverage). The overcoverage can usually be minimized by asking potential respondents to confirm their area of residence and then screening out any who do not reside within the targeted geographic area.[20] Weighting procedures for state/local surveys have an additional consideration to try to deal with this potential coverage error that does not arise in national surveys. The choice of different auxiliary variables for post-stratification control totals is one of the most common ways to deal with this.

At the state/local level there may be limited external control totals that are available, and which are accurate, reliable, and/or consistent over time. In a particular state/local area control totals

[20] As discussed in the section on Operational Issues, geographic screening must be crafted in a careful manner and interviewers must be well trained to administer it accurately to avoid Errors of Omission (false negatives) and Errors of Commission (false positives).

by telephone status (cell-only, dual user, landline-only) and telephone usage among dual users (cell-mainly or landline-mainly) may neither be available nor accurate enough to be used in post-stratification adjustments. Control totals by telephone status and usage are frequently used in weighting telephone surveys to reduce potential biases due to differential response rates by these characteristics. Of note, and as previously noted, the NHIS collects information on cell phone status and usage and reports estimates of these quantities at both the national and census region level every six months. Currently, no other federal face-to-face survey provides reliable estimates for these characteristics. The National Center for Health Statistics has used the data from the NHIS in conjunction with other data sources to produce *model-based estimates* of the prevalence of cell-only households and adults at the state level, but these estimates are for the cell-only population (not the full telephone status) and are subject to substantially larger errors than the national estimates.[21]

Researchers may develop their own model-based estimates using the NHIS and other sources of information such as the American Community Survey Public Use Microdata Sample (ACS PUMS). Battaglia et al. (2008), Battaglia et al. (2010), and Blumberg et al. (2009) should be consulted for examples of this approach.

As a result, national telephone surveys can use more reliable and up-to-date data for weighting than are available for state/local surveys. The availability of data for post-stratification may affect the choice of design (screening versus full overlap) and the weighting procedures. Both of these have consequences for the potential for bias of some of the estimates. In the absence of data to use as control totals in local surveys, Guterbock (2009) has suggested an approach that adjusts the phone usage distribution from the realized local samples by applying response-rate differentials calculated from comparison of national or regional samples with the appropriate NHIS control totals. ZuWallack and Conrey (2010) have proposed a response propensity approach to weighted state and sub-state surveys when external telephone service control totals cannot be obtained.

Finally, it may be possible that state/local level information that could be used in post-stratification adjustments is available from several smaller surveys serving varying

[21] See Blumberg, S., Luke, J., Davidson, G., Davern, M., Yu, T. and Soderberg, K. 2009. Wireless Substitution: State-level Estimates from the National Health Interview Survey, January - December 2007. http://www.cdc.gov/nchs/data/nhsr/nhsr014.htm

constituencies. In this case state/local level adjustments may require selection of a "best available" control total or a method for combining all control totals together to provide a more accurate measure for the area of interest via a small area estimation procedure or some other type of linking method.

Gathering Data Within Dual Frame Surveys to Determine Telephone Service Usage and for Post-Stratification

At a minimum, dual frame RDD telephone surveys require items to be added to *both* the cell phone and landline questionnaires that permit classification of respondents on the basis of telephone ownership and usage. In addition, for accurately weighting telephone surveys that include cell phone samples, certain data must be available about the target populations' parameters and the survey samples' characteristics. Thus, U.S. telephone researchers need to gather data in their questionnaire to facilitate this process by measuring those sample characteristics needed for proper weighting to be possible.

As previously noted there is no consensus regarding how RDD cell phone samples should be weighted, especially when combining them with RDD landline samples. As such, there also is no consensus on exactly what survey items need be asked of respondents to support this process.

To date, a mix of measures has been employed in RDD cell phone surveys for this purpose, including:

- Has the respondent been reached on a landline or a cell phone?
- Do the respondents reached on a cell phone also have a landline telephone?
- Do respondents reached on a landline also have a cell phone?
- Is the cell phone on which the respondent was reached used or answered only or mostly by the respondent?
  - If not, how many other eligible persons use/answer the phone?
- Does the respondent have other cell phones?
  - If so, considering all of the respondent's personal telephone usage, how much does the respondent use each of them?

For respondents with both a cell phone and a landline phone, what proportion of all of their incoming telephone calls are taken via each type of phone service?

What portion of a typical day is their cell phone turned on (e.g., number of hours a day)?

Is the cell phone used primarily for business purposes?

- If so, what portion of their usage is for incoming business versus incoming personal calls?

Does the respondent use alternate forms of communication via their cell phone (e.g., text messages, SMS, e-mail)?

Appendix B includes examples of the questions used for these purposes by several major survey organizations. This appendix should *not be considered an endorsement* of these questions, but rather is offered as a resource to researchers looking for examples of survey variables that could be gathered and how the questions have been worded by other survey organizations.

Factors to Consider in Selecting Questions for Weighting Purposes. These factors include the sample design (cell phone only, dual frame with screening for cell-only households/persons, or dual frame without screening), as well as the weighting parameters.

Weighting to external estimates is most effective when items in the questionnaire replicate as closely as possible the manner in which the data were gathered in the external survey. Researchers conducting national (and in some cases regional) surveys may consider using the most current telephone service estimates from the NHIS.[22] The NHIS features a large, national area probability sample that covers both telephone and nontelephone households. Data collection for the NHIS is continuous throughout the year, and parameter estimates for telephone service are published twice yearly (in December for interviews completed from January - June, and in May for interviews completed from July - December). For surveys making inference to smaller geographic areas, satisfactory parameter estimates may not be readily available, though state level cell phone only estimates are becoming available. As such, researchers who are conducting non-national telephone surveys of the general population must recognize that *weighting to inappropriate parameter estimates may not improve survey estimates and, in some cases, may increase error.*

[22] http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless200912.htm

There also are concerns about the reliability of many telephone service and usage questions. For example, the term, "landline telephone," is not a familiar term to everyone, and there is potential for some respondents to confuse *cordless* landline telephones with "wireless" cell phones. Furthermore, estimating the proportion of calls made on a cell phone versus a landline phone may be very difficult for some respondents, and in many cases their answers will be unreliable. Of note, Villar, Krosnick and DeBelle (2010) report that more reliable data will be gathered when respondents are asked about the proportion of their "personal" calls that are made and received via cell phone or landline rather than the data that are gathered without using the word "personal" (which is now the case in the NHIS survey items).

The questions used by the NHIS to measure telephone use are posed at the family level, are then aggregated to the household level (for households with multiple families or unrelated persons living together), and finally the status of all individuals in the household is based on the household-level measures. This matches the practice of most telephone surveys with respect to the presence of a landline telephone, which is assumed to be available to and used by all members of the household. For cell phones, the NHIS asks if anyone in the household has a cell phone. If the answer is "Yes," all members of the household are assumed to have access to that device. They are then assigned cell phone only status if there is no landline in the home, or dual phone status if there is a landline. Although the sharing of cell phones in a household, at least on occasion, is not an uncommon practice, the vast majority of people in the U.S. are thought not to share their phones with others in their household.[23] In addition, even when sharing goes on, it is likely that not all members of a household are equally accessible to incoming calls on a cell phone. Yet, as a practical matter, most surveys using cell phones do not ask about cell phone sharing or the accessibility of all household members via cell phone. As a consequence, there is a potential mismatch between the parameter estimates of telephone status from the NHIS and the telephone status of household members as measured by most telephone surveys.[24]

[23] As of 2010, there appears to be no reliable national estimate of the proportion of U.S. cell phone owners who share their cell phone with someone else, but most estimates put it the 10%-20% range (cf. Link et al., 2007).
[24] When cell phones are shared, it may be useful to determine the proportion of time the survey respondent uses this device as compared to other users of the same device. This can be applied in adjusting selection probabilities for having reached the respondent on this device. For example, a person using the cell phone only half the time would have a 0.50 chance of being included in the survey and thus the inverse of this probability would be used to correctly adjust their selection for inclusion.

The battery of potential telephone usage measures (see Appendix B) presents a number of practical concerns. A nontrivial amount of interviewing time would be required to be able to include all or many of these in a questionnaire, which in many surveys would likely necessitate a reduction in the number of substantive questions. These items are also apt to be uninteresting and potentially sensitive to many respondents, thus raising the chances for item nonresponse and even breakoffs occurring.

These are matters that must be worked out in the coming years so that valid standardized measures can be used to gather the variables needed for weighting RDD cell phone respondents in the U.S. Likewise, this must be done in ways that are reasonably cost effective for researchers who need to conduct telephone interviews with those reached on cell phones.

LEGAL AND ETHICAL ISSUES IN RDD CELL PHONE SURVEYS

U.S. Legal Restrictions on Calling Cell Phones – the TCPA

Under the federal Telemarketing Consumer Protection Act of 1991 (TCPA, 47 U.S.C. 227), which is enforced by the U.S. Federal Communications Commission (FCC), automatic telephone dialing systems *cannot* be used to contact a cell phone without the user's "prior expressed consent" – a content-neutral requirement that applies to all calls, including survey research calls.[25] The TCPA defines "automatic telephone dialing system" as equipment that has the capacity to store or produce telephone numbers to be called using a random or sequential number generator, in conjunction with dialing such numbers. As clarified by the FCC's 2003 report, this includes all forms of autodialers and predictive dialers, and applies to intrastate calls, interstate calls and calls from outside the United States.[26]

The Need for Manual Dialing. To ensure compliance with this federal law, in the absence of express prior consent from a sampled cell phone respondent, telephone research call centers should have their interviewers *manually dial cell phone numbers* (i.e., where a human being physically touches the numerals on the telephone to dial the number). Of note, there is no "good faith exception" for inadvertent or accidental calls to cell phones, so not knowing that a cell phone number is being dialed (as happens in RDD landline samples that unknowingly reach cell phones) is not an acceptable excuse for violating the U.S. federal regulations. However, this does not include circumstances where a landline number has been forwarded to a cell phone; thus reaching a cell phone as a result of using an autodialer to call the sampled landline number does not violate U.S. federal law.

The Permitted Use of Neustar. Although telephone sample providers have been made aware of this law, and Neustar provides a useful service for recognizing cell phone numbers that have been "ported" from residential lines, their methods may not be a perfect solution to the problem. The Neustar database cannot be used by researchers to identify numbers in the landline frame for inclusion in a cell phone sample. Rather, to be in compliance with federal regulations, the Neustar database can only be used to purge cell phone numbers from a landline sample.

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[25] See http://www.fcc.gov/cgb/policy/telemarketing.html and http://www.law.cornell.edu/uscode/47/227.html
[26] See http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-153A1.pdf

At the present time, the Marketing Research Association (MRA) is working for the benefit of the research community to amend the TCPA to exempt research calls.[27] However, in the meantime, research call centers should only use manual dialing to reach cell phone numbers unless *expressed prior consent* has been received from the respondent that it is permissible to call her/him on her/his cell phone. This consent would occur, for example, if a respondent is first contacted on a cell phone that was hand-dialed by an interviewer, and agrees to the scheduling of a callback to that number. If this were to happen, then the research center could use its autodialer to place future calls to this cell phone number.

Of note, the requirement of expressed prior consent precludes outbound IVR (interactive voice response) and outbound TDE (touchtone data entry) surveys, which do not use manual dialing, from conducting an RDD survey of the cell phone frame.

Legal Considerations Regarding Text Messaging and Spam

The TCPA restrictions on using an automatic telephone dialing system to call a cell phone could apply to the sending of text messages as well as regular telephone calls. However, several appeals court cases have recently left the TCPA's application unclear. In addition, researchers that send text messages to cell phones in compliance with the TCPA (either manually or with expressed prior consent) could find their messages subject to the CAN-SPAM Act (16 CFR Part 316), which regulates commercial e-mail (spam).

Even though legitimate survey and opinion research is not defined by the TCPA as being "commercial" in nature, researchers are encouraged to always include opt-out notices and capability in text messages, as would be required under the CAN-SPAM Act. There also are numerous state laws regulating bulk e-mail and spam, and unsolicited telephone calling, of which researchers should be aware. Researchers should consider the implications of those laws that may apply to any cell phone survey they may be planning to conduct in particular states.

[27] See the MRA's Government Affairs site: www.mra-net.org/ga

Legal and Ethical Considerations Regarding Possible Harassment Due to the Number of Callbacks Used

There are various state level harassment laws in the U.S. that need to be considered when determining the placing of callbacks to a cell phone respondent. For example, under current Utah law, it is illegal for anyone to cause a telephone to ring “repeatedly” or “continuously” (the law is not more specific). Under Missouri law, it is considered harassment for anyone to make "repeated" telephone calls; (in one case brought under the law, four call attempts to an answering machine were sufficient to constitute harassment). In Hawaii, it is illegal to “repeatedly” make a communication anonymously or at an extremely inconvenient hour; and in Montana one cannot use a telephone to disturb, by repeated telephone calls, the peace, quiet or right of privacy of a person. Although a matter of interpretation, multiple callback attempts to a respondent runs the risk of violating any one of these state laws.

With the advent of Caller ID, even though a cell phone respondent may not hear the phone ring all of the times a survey organization calls, the respondent often will have a record of how many times calls from a given number have been made to her/his cell phone. Thus, in addition to being a possible ethical violation of what many might construe as “harassment,” and regardless of whether it also is a legal violation, those planning to conduct cell phone surveys need to think carefully about how multiple callbacks may affect their final response rates if they alienate cell phone owners throughout the survey field period with “too many” (e.g., more than 10) and/or “too frequent” (e.g. several calls within a 24-hour period) callbacks.

Ethical Considerations for Time-of-Day Calling Restrictions

Federal law limits telemarketing calls to between the hours of 8:00 a.m. and 9:00 p.m. local time for the respondent being called. State laws can restrict those hours further, and some states have specific content-neutral time-of-day restrictions for the use of autodialers. Even though telephone survey researchers are not restricted by these laws, MRA recommends that researchers abide by the applicable federal and state laws regarding time of calling for the location of the respondent being contacted.

This is further complicated in cell phone surveys because some people likely will be reached in another time zone than the ones the survey sample is meant to cover geographically. Thus, "local" time for a cell phone respondent might be other than what the survey organization assumes it is based on the area code of the cell phone being dialed. Therefore, interviewers who work cell phone survey samples should be trained about how to politely explain the inadvertent problem of reaching someone in a different time zone "too early" or "too late."

Ethical Considerations for Taking Safety and Respondent Privacy into Account

As noted previously in this report, research has indicated that approximately one third of cell phone respondents in the U.S. complete their interviews in a location away from their home (cf. Lavrakas et al., 2010). The mobile nature of cell phone technology allows for a respondent to be engaged in numerous activities and to be physically present in various locations that would not normally be expected in reaching someone on a fixed landline number. In particular, the operation of a motor vehicle or any type of potentially harmful machinery by a respondent during a research interview presents a potential hazard to the respondent and to anyone else in the general vicinity of the respondent (e.g., fellow passengers in the car). However, even if someone is merely walking about while speaking on their cell phone, this could raise their chances for physical harm occurring (cf. Richtel, 2010).

Any researcher who conducts a survey that reaches people on a cell phone should take appropriate measures to help protect the safety of the respondent and whoever else may be nearby. For example, merely asking respondents whether they are operating a motor vehicle is insufficient because the potential risks from distraction are not limited to driving. Questions about specific activities also suggest inappropriately that the researcher is in the best position to make judgments about respondents' safety (and to accept the consequences of an incorrect judgment). Therefore, it is suggested that researchers leave the responsibility for determining safety to the respondents themselves and encourage respondents to consider their own safety by asking about it directly (e.g., "Are you in a place where you can safely talk on the phone and answer my questions?"). If respondents indicate that they cannot safely talk, contact should be quickly ended, and interviewers should not extend the contact at that time by attempting to schedule an appointment for a callback.

Some survey respondents reached on cell phones may be seemingly oblivious of other persons in their vicinity who may be listening (willingly or unwillingly) to their conversation. As such, respondents in public or semi-private places should not be required to verbalize responses that could:

1. Reasonably place them at risk of criminal or civil liability;

2. Be damaging or to their financial standing, employability, or reputation; or

3. Otherwise violate their privacy.

For example, asking someone questions about their history of criminal victimization or sexual behavior while they are on their cell phone in a public place may be very embarrassing to them, and likely would lead to a breakoff that could have been avoided had the researchers anticipated such circumstances.

Thus, whenever it is appropriate, and based on the nature of the topics being surveyed, researchers should have interviewers determine whether respondents on cell phones are in an environment where privacy can be maintained. Alternatively, whenever it is appropriate and based on the nature of the topics being surveyed, researchers should design their cell phone questionnaires so that answers to sensitive questions may be provided in a nondisclosive categorical format (e.g., answering with a “A, B, C” or “1, 2, 3”) rather than voicing more disclosive responses.

Also, it is suggested that checks on safety and privacy be made independently and at different stages of the interview. For example, a question about safety could appear immediately after a brief introduction, and/or midway through the questionnaire. Questions about privacy could follow a description of the survey, which would permit respondents to make informed decisions about the risks of disclosure.

Ethical Considerations for Remunerating Cell Phone Respondents

This topic is discussed in more detail under the next section of this report on Operational Considerations. Suffice it to say here that the issue of remunerating cell phone respondents in

the U.S. stems from the ethical concern that survey researchers not do any harm to a survey respondent, including not causing the respondent to bear any financial burden on behalf of the researcher.

The Ethics of Transmitting Accurate Caller Identification Information

Given that cell phones in the U.S. routinely display the number of the party that is calling, researchers should avoid any inadvertent or purposeful falsification of Caller ID information, either in terms of the number displayed or the name of the calling party. MRA recommends that all researchers use (or require their calling centers and data collectors to use) calling equipment that is capable of transmitting Caller ID information and ensure that the telephone number and other identifying information that is transmitted allows the call recipient to identify the entity making and/or responsible for the call. It also is advised that the transmitted number be one that the respondent can call back on.

Research indicates that, "the Caller-ID transmission works as a sort of 'compact invitation letter,' similar to that found for advance letters which underscores the legitimacy of a survey, takes away suspicion, and communicates the value of the survey thereby positively influencing response rates" (Callegaro, McCutcheon and Ludwig, 2005). The effect of this on telephone survey response rates, at least with landline RDD samples, has been shown to be a positive one (cf. Trussell and Lavrakas, 2005).

The Ethics of Maintaining an Internal *Do Not Call* List

Because nonresponse due to refusals often has been found to be higher in cell phone surveys compared to similar landline surveys, it is likely that proportionally more persons contacted on their cell phone will tell an interviewer "No, I won't participate, and put me on your Do Not Call list!" than will happen within a landline sample. Thus telephone survey organizations that conduct cell phone surveys should consider the ethics of maintaining an internal list of cell phone numbers to respect the wishes of owners who have requested not to be called again by the organization. This list would be used to screen a cell phone survey's initially designated sample of RDD numbers and matches would be purged. (Similar to what should be done when

purging such numbers from landline samples, all the purged cell phone numbers should be treated as refusals in any response rate calculations for that cell phone survey.)

In setting up an internal Do Not Call list, a survey organization should give explicit consideration to (1) how quickly the number should get added to the list, (2) how long the number should remain on the list, and (3) what respondents should be told if they ask questions about the list.

OPERATIONAL ISSUES IN RDD CELL PHONE SURVEYS

As detailed in the Nonresponse section of this report, one problematic aspect of RDD cell phone surveys in the U.S. is their low response rates, which generally have trended below those of list-assisted RDD landline surveys. There are myriad reasons for the low response rates, such as the inability to send advanced notification to the sampled respondent, the perception of many that their cell phone is a private form of communication that strangers (e.g., an interviewer) should not be calling, the cost of minutes for the incoming call, and the potential to reach a respondent anywhere (e.g., shopping, at work, driving).

Over the last few years, many research organizations have conducted cell phone surveys in the U.S., and some of these surveys have included experimental designs to test the most effective operational methods for increasing response rates and potentially limiting nonresponse bias. In this section, seven operational topics related to the implementation of cell phone surveying are addressed: (1) calling rules/protocols, (2) call dispositions, (3) voice mail messages, (4) scheduled callbacks, (5) remuneration and incentives, (6) interviewer training, and (7) interviewer assignments to cell phone samples.

Calling Rules/Protocols

As with RDD landline surveys in the U.S., calling an RDD cell phone sample should be attempted on different days of the week and at different times of day. Cell phone surveys carried out to date have used different calling protocols. These have included calling mainly during early evenings and on weekends when most users have free service; however, some studies suggest that contact and cooperation may not be that different across the different day-parts. More research is required to determine the optimal calling pattern across different days and time slots for RDD cell phone surveying in the U.S.

Geographic Mobility. Furthermore, because cell phones can be in use in geographical areas other than where the cell phone's area code is located (e.g., a respondent is away on business or vacation, or simply has moved to another location), calling windows may need to be modified to reduce the chances of reaching a respondent who has moved to, or is currently in a different

time zone at a local time considered too early or too late for calling there. At present, it is unclear what percentage of the U.S. cell phone population may be affected by this consideration, but it is likely to increase over time.

Geographic Screening and Other Eligibility Screening Implications. As the size of the geopolitical area for the target population of an RDD telephone survey *decreases*, the need to geographically screen people who are reached *increases*. This holds for landline RDD surveys and for cell phone RDD surveys. However, for cell phone surveying, researchers face the need for geographic screening in nearly every study that is not national in scope, including those carried out at the state level. Thus in most non-national cell phone surveys some type of geographic screening will be required so as to screen out those who no longer live within the area the survey is covering.

If the area to be covered by the survey has a well-known and a well understood name (e.g., “Illinois” or “Cook County” or “Chicago”), the question that is asked of those reached on their cell phone is straight-forward, although it should be worded in a manner that does not tip off the person being spoken to as to what answer will qualify or disqualify the potential respondent to be interviewed. Thus for example, it would be better to ask, “In what county do you live,” rather than asking, “Do you live in Cook County?” The latter will yield far more false negatives (errors of omission).

If the area to be covered by the survey does not have a well-known or a well understood name (e.g., Chicago’s “Northside,” may be well known, but isn’t reliably understood), the questions that are asked of those reached on their cell phone are not straight-forward (cf. Lavrakas, 2010). Again these questions should be worded so that the person being spoken to is not tipped off as to what answers will qualify or disqualify her/him from being eligible for the survey. It is highly recommended that researchers pilot test the accuracy of their geographical screening sequence for small area cell phone surveys so as to avoid both false positives (i.e., those who answer the screening questions inaccurately and get screened in when they should have been screened out) and false negatives (i.e., those who answer the screening questions inaccurately and get screened out when they should have been screened in).

Cell phone surveys also may cause more operational challenges to a survey staff than landline surveys in that the rate of eligibles may be so low that interviewer morale suffers greatly from

the frustration of having to screen out the vast majority of persons contacted. If a cell phone sample for a given survey is limited to only those who do not also have a landline even more of those reached will be screened out.

In additional to screening for geographic or telephone user type eligibility, cell phone surveys have a special responsibility to screen for *age eligibility* given the great number of nonadults who use a cell phone. This too can create extra operational burdens on a research call center staff.

Inbound Calls. Initial research and experience has shown that in the event of a missed call, cell phone users are more likely than landline users to attempt to recontact the number that appears on their Caller ID. As a result, researchers should consider the implications for the survey research calling center to handle such inbound calls.

As previously noted in the Legal and Ethical Considerations section, the calling center's phone number that displays on the cell phone's Caller ID should be able to be redialed by the respondent. Ideally it will reach an inbound line on which an interview can be conducted.[28] In turn, calling centers should be prepared and able to schedule a callback day and time if it is not possible to conduct the interview at the time of the respondent's inbound call. Interviewers also need to be able to enter an alternative telephone number into the CATI system for recontact purposes, such as a residential or work number, if requested by the respondent. At a minimum, the call center should have a message that is played to incoming callers alerting the potential respondent that this contact was for a legitimate survey and that a callback will be made at a future time. This message also might provide additional information and motivation for the respondent about the survey.

Number of Call Attempts. Although higher response rates may be achieved by increasing the number of call attempts to cell phone respondents, the personal nature of the cell phone suggests the need for caution with this strategy, due in part to the anti-harassment issues discussed in the Legal and Ethical Issues section of this report.

[28] It should be noted that although 800- numbers are toll free when dialed from a landline phone, they are not free when calling from a cell phone.

To reduce the potential for overburdening (and likely harassing) the cell phone respondent pool, it is recommended that the total number of call attempts be limited to a modest number, perhaps in the range of six to 10, as compared to the greater number of attempts often used when surveying landline telephone numbers. (The length of the field period should be taken into consideration when deciding what will be the maximum number of call attempts in a cell phone survey.)

Refusal Conversions. Logic and anecdotal evidence to date suggest that refusal conversion attempts to cell phone respondents should be of a limited nature so as to reduce the potential for further agitating them. This is in large part a result of likely reaching the same respondent who previously refused rather than reaching some other member of the sampling unit (household), as often is the case when trying to convert refusals in RDD landline surveys.

However, until more research on the efficacy of refusal conversions in cell phone surveys has been reported, there is little to guide researchers on what might be an optimal procedure to follow (e.g., how long a time should pass after the refusal before a conversion is attempted?) when considering whether to try to convert initial cell phone refusals.

Call Dispositions

Compared to the standard protocol of allowing a landline number to ring at least six times before coding it a "Ring No Answer (RNA)," experience suggests that interviewers should allow the cell phone to ring a *minimum of eight times* before dispositioning it as RNA. Furthermore, more often than not, it takes as many as eight rings before a voice mail initiates on a cell phone, so not waiting for the extra rings would incorrectly disposition the call as a RNA instead of the correct "voice mail" outcome, as well as precluding the interviewer from leaving a voice mail message if that is what the researchers choose to have done; (see section below on voice mail messages).

As discussed in the Nonresponse section of this report, ambiguous operator messages often make it difficult to disposition calls to cell phones in the U.S. appropriately. Possible future developments, such as industry consolidation, may help to reduce these types of unresolved calls in U.S. RDD cell phone surveys. In the meantime, it is recommended that research

organizations that call cell phones maintain a database of these messages and how the call was dispositioned (e.g., disconnect, voice mail, etc.). In terms of dispositioning these calls, it is recommended that the most conservative approach be taken so that the response rates are not unduly inflated. Researchers also are encouraged to work with cellular phone companies to better understand these operator messages. Moreover, researchers are encouraged to share these lists via AAPORnet or AAPOR's Standard Definitions Committee[29] or via AAPOR's online journal, *Survey Practice,*[30] to help the field develop standard protocols for properly dispositioning the outcomes that may result when calling cell phone numbers in the U.S.

Voice Mail Messages

Benford et al. (2010) provide experimental evidence using three national RDD surveys that leaving a message on a cell phone does not appear to improve the odds of getting a completed interview, but does improve the likelihood that a callback will occur and decreases the likelihood of a refusal. However, more research is needed on this topic as Peytchev and Krotki (2010) found that voice mail messages had no discernable impact on survey performance rates.

Leaving a voice mail message on the first call attempt to a cell phone can, in theory, act as the important pre-alert of the survey request if no one is reached by the interviewer. This may be particularly important given that mailing addresses are not currently available for matching to U.S. cell phone numbers, thereby preventing the use of mailed advance contact letters, which is possible with RDD landline surveys.

In addition, researchers are encouraged to include a callback number in this message, especially if the outbound number that appears on the cell phone's Caller ID is not valid for an inbound callback. Much more research is needed to understand what the content of messages left to voice mail should be within a cell phone survey and also how often it is prudent to leave such messages. However, it is not recommended that a message is left every time an interviewer reaches someone's voice mail, but it is thought to be useful to have such messages occasionally left on subsequent contacts with voice mail.

[29] The AAPOR Standard Definitions Committee chair, Tom W. Smith, should be contacted; smitht@norc.uchicago.edu.
[30] http://surveypractice.org/

Scheduled Callbacks

Several instances may occur that require the ability to schedule callbacks at a later date/time as well as to record a different telephone number on which to reach the cell phone respondent:

First, experience shows that cell phone respondents, on average, are more likely to be under time constraints than when an interviewer is reaching someone on a landline. Furthermore, many cell phone users in the U.S. will be incurring costs per minute which may exacerbate their desire to end the call quickly.

Second, when asking sensitive survey questions, such as about unethical behaviors, illegal acts, or financial issues, interviewers should assess whether the respondent is in an environment conducive to providing full and honest answers. If this is not the case, interviewers should schedule a callback. (See the section of this report on Measurement for further discussion of issues of data quality when contacting respondents on a cell phone.)

The third instance is related to respondent safety. Because of the mobile nature of cell phones, a cell phone respondent may be put at risk when speaking to an interviewer, such as when driving or biking or even walking (cf. Richtel, 2010). These too will lead to occasional contacts for which the interviewer may want to schedule a callback. But as advised in the previous section on Legal and Ethical Issues, as soon as an interviewer is told that a respondent is in an unsafe situation, the call should be politely terminated and time should not be taken to schedule a specific callback. Instead, in terminating the call, researchers may want to have the interviewer say something to the effect that, “we will call you back at another time when it is better for you to speak with us.” (More discussion of respondent safety appears in the sections of this report on Nonresponse and on Legal and Ethical Issues.)

Remuneration and Incentives

Because of the cost structure of cell phone billing currently in the United States, there often may be a financial burden upon the respondent for an incoming research call – something that does not occur with a landline phone. Therefore, when appropriate, it is recommended that interviewers offer a form of remuneration to offset this cost to the respondent. Remuneration is

not the same as incentives; which is of particular importance where government sponsorship of a survey is involved.[31]

Experience to date with cell phone surveying in the U.S. has shown that few organizations have perceived the need to offer both a contingent remuneration and a separate contingent incentive. To date, survey firms appear to use one of two approaches to handling these issues.[32]

In one approach, the interviewer is instructed to not mention offering a cash gift unless the respondent displays reluctance or explicitly complains about the call causing her/him to incur costs to cell phone minutes. This approach is not consistent with what is recommended to be done concerning remuneration by this Task Force; (see section on Legal and Ethical Issues).

In the second approach, the introductory script spoken by the interviewer includes an explicit mention to all respondents contacted via cell phone that a monetary amount will be sent to the respondent upon completion of the questionnaire. Some of the time the reason for this includes saying something to the effect that "this is to help offset the cost of your cell minutes." Typical amounts being offered appear to be either $5 or $10, although higher amounts have been offered when the survey includes an especially long questionnaire. The use of the word "payment" (as in "payment for your minutes") or the words "incentive" or "remuneration" typically are not used.

Experiments Testing the Effects of Cell Phone Remuneration and Incentives. Only a few studies have featured experimentally controlled comparisons of different remuneration and incentive conditions.

Brick and his colleagues (2007) found that a $10 incentive significantly improved respondent participation over a $5 incentive in a 2004 national survey of cell phone households. However, the Pew Research Center (2008) found virtually no difference in the response rate between cell phone respondents offered $10 and those offered $20 in a randomized experiment. In another experiment with cell phone incentives, it was found that a $10 cash incentive achieved a higher rate of production (completes per hour) in an 18 minute citizen satisfaction survey compared to

[31] For more information on the distinction between remuneration and incentives, please see OMB guidance (p. 68-71) on survey design, downloaded at (11/30/2009):http://www.whitehouse.gov/omb/assets/omb/inforeg/pmc_survey guidance_2006.pdf

[32] Gallup routinely fields cell phone samples in additional to landline samples in their national telephone surveys. Jones (2008) reported that Gallup's protocol is to offer neither remuneration nor incentives for cell phone respondents (or landline respondents). This policy is based in part on the American public's familiarity with the Gallup brand.

no incentive (Diop, Kim, Holmes and Guterbock, 2008.) Consistent with Brick et al. (2007), an experiment by Diop, Kermer and Guterbock (2008) found that a $10 incentive improved production over a $5 incentive – so much so that the overall total cost of cell phone interviewing actually was lower using the larger cash incentive. Finally, in a recent experimental study with cell phone only respondents using a $10 gift card as the incentive versus a no incentive control condition, no effect on response rates was observed (Oldendick and Lambries, 2010).

Much more experimentation with the use of remuneration and incentives in cell phone surveys will be needed before researchers can be confident of the effects these may have on response rates, data quality, and/or nonresponse bias. This research should include factorial designs in which some of the conditions use both a remuneration and a contingent incentive. The experimentation also should include varying the manner in which the purpose of the remuneration and/or incentive is explained (i.e., characterized) to the respondent.

Further Operational Matters to Consider. A survey organization needs a reliable infrastructure to fulfill the sending of the promised remuneration and/or incentives to the respondent. Interviewers will need to gather information from the respondent at the end of the interview to allow the funds to be given to the respondent. Of note, experience has shown that some respondents who are told they will receive a monetary amount or other gift for participating in a cell phone survey decide not to receive the money, as they choose not to disclose their mailing or e-mail address to the interviewer, or for other reasons.

Interviewer Training

Although many researchers seem not to recognize it, interviewing respondents by cell phone is a more complex task for the interviewer than is interviewing a respondent on a landline. The calling protocols, dispositioning, eligibility requirements, and interviewing techniques may be quite different. Therefore, researchers should ensure that interviewers are properly trained to handle these interviewing requirements and have the tools (e.g., scripts, persuaders, and other protocols) at hand that are tailored/targeted to the special needs that interviewers will have when cell phone respondents are reached.

General Interviewer Training for Cell Phone Surveys. The general training that all interviewers who will work on U.S. telephone surveys receive when they first are hired might include a training module that is specific to calling cell phone numbers and reaching cell phone respondents. However, a survey calling center may decide that cell phone interviewing is only appropriate for interviewers who already have demonstrated their interviewing ability on landline samples. If so, the cell phone general training module would be administered to experienced interviewers prior to their being trained and allowed to work on a specific cell phone study.

The general training module for conducting interviews with respondents reached on a cell phone would include training about how calling protocols, call dispositions, and respondent eligibility screening are performed by the call center when conducting a cell phone survey. This part of the training is not merely a time to provide cursory information to distinguish what interviewers do differently when cell phone numbers are being processed from what is done when landline numbers are being called. Instead, the cell phone training should be treated as a separate skill set and thus deserves its own unique and separate module within the larger training interviewers receive. As part of their general cell phone training, interviewers should also come to understand and respect the need to hand dial all cell phone numbers. Thus, some of the details of the TCPA should be explained to interviewers – in particular, the ones pertaining to manually dialing cell phone numbers.

Interviewer Training for Specific Cell Phone Surveys. When interviewers receive training for a specific survey on which they will work that includes calling cell phone numbers, all the topics that are addressed in general training should be addressed again in a fashion that is tailored to the specific cell phone survey in which the interviewers will be engaged. Interviewers also should be told how they will be assigned to the cell phone and landline samples, if both types of samples are being used in a given survey.

Some examples of situations that interviewers should be trained to handle in specific cell phone surveys include:

- *Geographic Eligibility* – for surveys that are targeted to collect data for specified geographic areas (e.g., city, county, MSA, state), screening questions and interviewer probes should be developed to ascertain whether the person reached is geographically eligible.
- *Age Eligibility* – from the premise that cell phones are more of a personal device, it is more likely to reach children/minors directly rather than via a landline phone number. Interviewers should follow study-specific/organizational rules on probing for age and data collection from minors.
- *Group Housing/Other Eligibility* – from the premise that cell phones extend phone coverage to respondents living in housing that is traditionally excluded from household surveys, interviewers should be trained to probe as appropriate to deploy these types of respondent eligibility rules.
- *Respondent Location* – although some cell phone surveys may have a question to ask if the respondent believes that s/he is in a safe location to answer the survey questions (see the Legal and Ethical Issues section of this report for more information), researchers may choose to train interviewers how to probe if they believe that the respondent's location has changed during the call. For example, if the respondent is heard getting into a vehicle and then driving away, the interviewer might ask if the respondent is currently in a safe location to answer survey questions.

As interviewers gain experience in performing cell phone surveys, feedback on what concerns arise, what situations they encounter, and how they are reacting to them should be collected by survey firms. If warranted, interviewer training should be modified to deal with these situations.

Interviewer Assignment to Cell Phone Samples

As noted previously, it can be very frustrating and debilitating for interviewers in the U.S. to work a cell phone sample. Not only are they required to hand-dial the numbers – at a minimum on the

first time the number is called[33] – but they often have to engage a respondent who is less than willing to talk with them. Furthermore, the screening often required in cell phone surveys disqualifies many of the people who are reached. All these factors conspire to place a special burden on interviewers who work cell phone samples that typically is not present when they work landline samples. Because of this, many survey centers have learned that it is best to rotate interviewers on and off of cell phone samples so that they do not burn out.

Another consideration about the allocation of interviewers to cell phone samples: It is not recommended that interviewers work landline samples and cell phone samples on the same survey during the same work shift. The rationale for this is that cell phone interviewing is different enough from working landline samples that it is best for an interviewer to focus on doing her/his best on one type of sample at a time within a given shift.

Of note, it is generally advisable to set up a dual frame project as two separate "studies" in the CATI system. This facilitates setting up appropriate outcome (disposition) codes for the cell phone frame and allows researchers to separately track production rates, costs, and response rates for the cell phone side and the landline side of the project.

A final consideration: One might speculate that there could be a cost benefit to offering interviewers extra pay when they work a cell phone sample. The reasoning here is that the extra pay may make them more productive with the cell phone sample, including improving their response rates, which in turn could save on other survey costs that may offset the extra pay. However, currently there is no empirical evidence that this would in fact result.

[33] Once a respondent is reached on a cell phone, the respondent may give explicit or implicit permission to be called back on the cell phone. If that happens, then the requirement that the callback to the cell phone number be hand dialed no longer holds in the U.S. However, call centers may not have the technology required to differentiate which cell phone numbers must be hand dialed and which can be dialed with an autodialer. As such, many call centers may simply have interviewers hand dial all cell phone numbers regardless of the results of any previous contact with the cell phone respondent.

COSTS IN RDD CELL PHONE SURVEYS

It has been clear from the first studies with RDD cell phone surveying in the U.S. that in most cases its cost is substantially greater than the cost of similar surveying of persons sampled and interviewed via landline RDD. During the past decade, the survey industry has accumulated sufficient experience with RDD cell phone surveys that it is now possible to provide a reasonably reliable assessment of the magnitude of the cost differential between RDD cell phone and RDD landline surveying and to gain a reasonable, albeit preliminary, insight into the factors that drive RDD cell phone interviewing costs.

For this report, specific cost data from more than 30 dual frame RDD surveys were gathered from four academic and four commercial survey organizations. Using these data, analyses were conducted comparing RDD cell phone and RDD landline costs in dual frame surveys where each type of sample was pursued under otherwise similar constraints and conditions. In this section, general cost factors that create a cost differential between RDD and cell phone interviewing are first considered. Then a review is provided of the data that were gathered to assess average cost differentials and to identify some of the conditions that cause the cost differential to be lesser or greater in different research applications.

Factors that Create Cost Differentials between RDD Landline and RDD Cell Phone Surveying

If one calculates the cost per completion for the cell phone part of an RDD survey and divides that by the cost per completion of the landline RDD arm, the resulting quotient yields the *cost ratio* of cell phone to landline RDD data collection. This cost ratio is affected by several factors, including: (1) interviewer time; (2) the cost of sample numbers; (3) the use of remuneration and/or incentives; and (4) possible mailings sent to respondents. Some of these factors operate on cost by affecting interview productivity, whereas others operate more directly on total costs.

Additional Interviewer Time Differentially Increases Cell Phone Survey Costs. The primary reason for the greater cost of RDD cell phone surveying compared to RDD landline surveying is the lower productivity of cell phone sampling/interviewing. Simply put, it takes more hours of interviewer time to achieve a given number of completions from an RDD cell phone sample than

it does from a traditional list-assisted RDD sample drawn from working blocks of phone numbers assigned to landlines. Interviewing time is the fundamental cost unit of telephone survey budgets: an hour of an interviewer's time in the CATI center entails not only that employee's wages and benefits, but a portion of the time of the supervisors, an hour of phone dialing and accrual of telephone charges, and other infrastructure overhead.[34]

Below, some of the factors that contribute to the lower hourly productivity of cell phone interviewing are considered, but first attention is given to some other cost components.

Cost of Sample Numbers Differentially Increases Cell Phone Survey Costs. Irrespective of the interviewing hours a survey requires, the sampled phone numbers are acquired at a cost, usually purchased at a fixed per-number rate from a commercial sampling vendor. As discussed in the Nonresponse section of this report, RDD cell phone calling is generally less productive than calling RDD landline numbers, for various reasons including the screening often needed to determine respondent eligibility. Thus considerably more numbers must be purchased and attempted to achieve a given number of completed cell phone interviews.

If RDD cell phone and RDD landline numbers are purchased at the same price, the cost for a cell phone RDD designated sample will be correspondingly higher than the cost for a landline RDD designated sample. However, since there is no effective prescreening service available for U.S. cell phone numbers, cell phone samples in the U.S. do not carry the additional charges associated with automated pre-screening for business and nonworking numbers.[35] Of course, this inability to prescreen cell phone samples greatly increases the total size of the sample of RDD cell phone numbers a given survey must process manually with its interviewers, which in turn further increases total costs for processing the cell phone sample.

Remuneration/Incentives Differentially Increase Cell Phone Survey Costs. Another set of costs apart from telephone interviewing costs are the costs of cash or the other remuneration and/or incentives offered to respondents, either prior to or after a cell phone interview completion, as well as the costs of other triggers that may be used to encourage response, such as advance letters or refusal-conversion mailings, which are possible with landline samples.

[34] The fixed charges of running a CATI research facility typically are billed back to clients/sponsors as an overhead charge applied to the hourly interviewing rate. Any factor that increases the Hours per Completion (HPC) – and correspondingly lowers the Completes per Hour (CPH) – will have a large direct effect on the overall study cost. These costs are nearly always the major portion of data collection costs in the production phase of an RDD telephone survey.

[35] Thanks to Frank Markowitz of SSI for clarifying sample cost issues in a personal communication.

It is fairly common in dual frame RDD telephone surveys to offer a small ($5 or $10) cash or gift-card remuneration to cell phone respondents, usually conditional upon interview completion. The ethical rationale for these remunerations, which traditionally have not been offered to landline RDD respondents, is that they serve to "compensate" a respondent for charges incurred as a result of using the cell phone to complete the interview. (See more discussion in the Legal and Ethical Issues and the Operational Issues sections of this report.)

The offering of these monetary gifts may increase rates of response in cell phone interviewing (Brick et al., 2007; Diop et al., 2008; and Diop et al., 2008), but the effects reported in the research literature have not been consistently positive (Pew, 2008; Oldendick and Lambries, 2010). Monetary gifts may be more effective in promoting survey participation among cell-phone-only respondents because some of these persons are thought to be more "cost-conscious" and are likely to fit the demographic groups (e.g., young, unattached, lower income, renters) for which gifts of material value tends to carry more "leverage and salience" than other, less tangible rewards of participating in a survey (cf. Groves, Singer and Corning, 2000). However, other cell-only persons likely have calling plans with unlimited or large amounts of monthly minutes, and may not be affected by offers of remuneration.

Furthermore, when cash or gift cards are sent to respondents, there are additional postal and administrative processing costs. Since the remuneration is given to cell phone respondents and not to the landline RDD respondents, they increase the cost differential between the two types of telephone surveying.

Possible Mailings Differentially Increase Landline Survey Costs. Advance letters and refusal-conversion letters, whether mailed with or without a token cash incentive, can be sent only to those for whom addresses are known. Therefore, they cannot be sent in advance to the vast majority of cell phone RDD cases, nor can they be sent to those landline RDD cases that have telephone numbers that fail to match to the databases used by matching vendors. If these postal communications are used in a survey for the matched landline RDD cases, the per-completion cost of the landline RDD side of a dual-frame survey is raised accordingly, which serves to somewhat diminish the cost differential between cell phone RDD and landline RDD interviewing.

Factors That Affect the Differential in Hourly Production Rates for Cell Phone RDD Surveys Compared to Landline RDD Surveys

As noted above, the biggest factors affecting the cost ratio in dual frame surveys are those that affect interview productivity. The hourly productivity (i.e., Hours per Completion or HPC) for any telephone sample is a product of the following factors:

- Working number rate,
- Contact rate,
- Eligibility rate,
- Cooperation rate,
- Interview length, and
- Dialing method.

Each of these may differ between RDD cell phone and RDD landline samples, most often in ways that yield lower productivity on the cell phone side.

Working Number Rate. The working number rate is a function of working number density in the number blocks from which sample is drawn. The differential in the working number rate is dependent on the relative density of working numbers within the cell phone and landline exchanges in use in a given sampling area; and these working-density ratios may vary from one area to another.

In most cases, list-assisted landline RDD samples select only “working” number blocks into the sampling frame, resulting in greater efficiency. In contrast, no such selection is possible for cell phone RDD samples because there are no publicly available directories or other sources listing cell phone subscribers. In addition, landline RDD samples can be prescreened to eliminate nonworking and business numbers, yielding a significant gain in calling efficiency, but this

prescreening is not possible for RDD cell phone numbers in the U.S. The overall result is a significantly lower working number rate for cell phone RDD samples.

Contact Rate. The contact rate is affected by cultural and technical differences in how people in the U.S. use cell phones as contrasted with how they use household landline phones. Many people use cell phones as a supplementary communication device. Many cell phones that interviewers call are turned off when called. Call screening/Caller ID technology is essentially universal on cell phones, as is voice mail; and both are thought to promote greater screening of incoming calls by respondents. The result may be a lower live contact rate for the cell phones numbers that are sampled. Furthermore, the contact rate is in part a result of the calling effort, and not all telephone surveys will apply equal effort to both sides of a dual frame survey. If the cell phone effort is lower (e.g., fewer call attempts per sampled cell phone number), then the size of cost differential would be reduced.

Eligibility Rate. These rates are lower in cell phone samples for several reasons and have major effects on survey costs for cell phone sampling:

1. *Not being eligible due to age.* Many more minors (persons under age 18) have their own cell phone compared to minors who have their own landline. Minors usually are not eligible for telephone interviewing in general population surveys, and they cannot as easily "hand off" the call to an eligible adult when reached on a cell phone, compared to what happens when ineligible young people are reached via a landline household telephone; nor is it often appropriate, due to the specifics of a cell phone survey sampling design, to have a minor hand off a cell phone to an adult.

2. *Not being eligible due to geography.* Cell phones can be purchased in one location and used in another, and often are. Thus, in non-national telephone surveys in the U.S., there are people reached by cell phone who reside outside the survey area. (This can occur also with landline phones, due to number portability, but currently this is not as prevalent as it is with cell phones.) For local area samples such as counties or cities, landline RDD can approximate the geographic area far more accurately and efficiently than cell phone RDD, which must rely on telephone company rate centers as the sampling unit for localized sampling. Thus, the cost differential between the cell phone part of the sample and the landline part due to these eligibility rate differences usually

will be greater when a dual frame survey is conducted in the U.S. within a non-national geography.

3. *Not being eligible due to type of telephone service screening.* A major factor in the eligibility rate differential between cell and landline samples is the type of dual frame design chosen by the researcher. Dual frame surveys that screen cell phone respondents and interview only those who are cell phone only will have considerably lower rates of eligibility than "all-cell" designs. If cell phone mostly respondents also are included as eligible, this will reduce the cost differential of this type of screening design, but nevertheless the cell phone component will remain more expensive than the landline component due at least in part to this screening.

4. *Not being eligible for other reasons.* Other study-specific screening procedures also may create differences in eligibility rates between the landline and cell phone parts of a dual frame survey. For example, a survey seeking young Hispanic males likely will reach more eligible cases on the cell phone side than on landlines; the opposite would be true for a survey of married female retirees. Many dual frame surveys use methods for random selection within the household on the landline side, but omit these procedures on the cell phone side, thereby accepting whoever answers a cell phone as the eligible respondent. This difference in determining who is eligible reduces the productivity differential somewhat between cell phone and landline RDD.

In sum, in most U.S. dual frame designs the cell phone sampling will have a lower overall eligibility rate, resulting in more time spent on screening and recruiting for the cell phone side, a higher HPC, and a larger cost ratio.

Cooperation Rate. The cooperation rate may or may not be different for cell phone and landline RDD surveying. As noted in the section of this report on Nonresponse, recent experience suggests less difference in the cooperation rates than had been experienced earlier in the previous decade when cell phone interviewing was beginning to be deployed in the U.S. If a monetary gift is offered to cell phone respondents and not to landline respondents, that can increase the cell phone cooperation rate and thus reduce the productivity differential. On the other hand, if mailed inducements such as advance letters, token cash incentives, or refusal

conversion letters are used on the landline side it will differentially increase productivity on the landline side, and thereby increasing the productivity differential.

Interview Length. If the length of the survey questionnaire differs between cell phone and landline questionnaires, this will have a differential influence on productivity for each sample. Yet, even if the two questionnaires are otherwise identical, cell phone interviews, on average, will take a minute or so longer due to the extra questions that may be needed about telephone service and usage, and time to gather information for distribution of any remuneration and/or incentive.

However, some studies use a shortened cell phone interview – in particular, some states participating in the U.S. Centers for Disease Control and Prevention's 's 2009 cell phone trials for BRFSS have chosen to use shortened interviews on the cell phone side. This may have the effect of increasing the cell phone response rate compared to what it would be with a longer interview. However, with topics that are interesting (e.g., health) and when conducted for "the public good," cell phone surveys with interviews as long as 30 to 35 minutes have been found to not suffer in their response rate (cf. Brick et al., 2007). If response rate is unaffected by the length of the interview and if the cell phone questionnaire is shortened, this will reduce the cost differential between the cell phone and landline surveys.

Dialing Method. The method of dialing that is used affects productivity. The required manual dialing of cell phones in the U.S. slows down the interviewing process and contributes to the size of the productivity differential. However, the degree of impact this has will depend on the dialing method used on the landline RDD side. Some telephone survey call centers (especially academic survey organizations) use autodialers to call numbers one by one while interviewers listen to the calls ringing. This process is faster than manual dialing, but certainly slower than a predictive dialer for RDD landline sample that "finds" a potential respondent on the line and serves the connection up to the next "available" interviewer. The average dialing times for cell phones also will differ if interviewers are instructed to let them ring longer (e.g., at least eight rings) before coding a RNA compared to landline dialing (e.g., at least six rings), or if cell phone dialing requires the interviewer to more often spend time leaving messages on the respondent's voice mail.

Summary of Cost Factors. The cost per completion for either part of a dual frame RDD survey (cell phone or landline) can be thought of as a sum of:

- The cost per completion of remuneration/incentives and/or advance mailings, if any;
- The cost per completion of the purchased sample phone numbers; and
- The interviewing costs per completion.

This third term is by far the largest factor in most telephone surveys and can be calculated as a product of the billing rate (or full cost) for an interview hour and the HPC. HPC can, in turn, be thought of as a sum of the interview length and the hours spent (per completion) on screening and recruiting – i.e., all interviewer time that is not devoted directly to completing the interview.

It is this last cost component – Screening and Recruiting Hours per Completion (SRHPC) – that is markedly higher for cell phone interviewing. Any differentials in the productivity factors listed above (e.g., working number rate, contact rate, eligibility rate, or cooperation rate) have a direct, multiplicative effect on the ratio of SRHPC in cell phone interviewing to SRHPC in landline interviewing. As is shown by the data presented below, the SRHPC ratio (cell phone SRHPC divided by landline SRHPC) drives the HPC ratio and the overall cost ratio as well.

Methodology for Gathering Cost and Productivity Data from Recent Dual Frame Surveys

During late 2009, a survey was conducted by the Cost subcommittee of the AAPOR Cell Phone Task Force to gather data from a select group of telephone survey organizations in the U.S. (Guterbock, Lavrakas, Tompson and ZuWallack, 2010). This survey used a purposive nonprobability sample of eight nationally known survey organizations (four commercial and four academic).[36] Telephone interviews were conducted by members of the Cost subcommittee with a senior researcher at each organization who was knowledgeable about the cost information that was to be gathered. Each of those senior researchers then had a spreadsheet assembled containing available information about each of the dual telephone frame surveys that the

[36] The survey organizations were promised their names would not be disclosed.

organization had conducted. These spreadsheets were shared in confidence with the Cost subcommittee members.

Information was provided about 38 separate dual frame RDD surveys. These surveys represented a mix of national, state and local surveys. The type of information that was gathered about the RDD cell and RDD landline samples in these surveys included: (1) number of completions, (2) average length of a completion in minutes, (3) geography covered, (4) screening criteria, (5) completes per hour (CPH), (6) incentive amounts, and (7) cost per interview (CPI). These data were used to generate various ratios for the analyses reported below.

Although it is acknowledged that the findings from this survey may not be representative of all recent dual frame RDD telephone surveying in the U.S., it appears to be the first time such cost data have been gathered from a wide set of survey organizations and about a relatively large number of dual frame telephone surveys. Thus, it is believed that the findings will do much more to inform, than misinform, the reader about the relative costs of cell phone RDD surveying in the U.S. compared to landline RDD surveying. Nevertheless, the reader is cautioned not to place an undue amount of importance on these findings until findings from a much larger and more representative cost survey become available.

Productivity and Cost Ratios in Current Dual Frame RDD Telephone Surveys in the U.S.

The cost and productivity data gathered about the 38 dual frame RDD surveys support the conclusion that RDD cell phone surveying achieves lower productivity than RDD landline surveying.

As shown in Table 3, the ratio of time devoted to screening and recruiting respondents (i.e., the SRHPC ratio) averages 2.5 times higher for the RDD cell phone samples than for RDD landline samples across the 26 surveys for which these data were available. No survey reported better productivity on the cell phone side compared to the landline side (i.e., this would be an SRHPC of less than 1.0); and the lowest ratio was 1.2. The standard deviation of 1.0 indicates that, if the sample is representative, about two-thirds of dual frame RDD surveys would have SRHPC

ratios between 1.8 and 3.8. The maximum SRHPC ratio among the 26 surveys shown in Table 3 was 5.4.[37]

Table 3
Productivity Statistics and Cost Ratios for Dual Frame RDD Surveys

	Screening and Recruiting Hours per Completion	Hours per Completion	Overall Cost per Interview
Ratio (cell/landline)	SRHPC Ratio	HPC Ratio	Cost Ratio
Mean	2.53	2.00	2.05
Minimum	1.21	1.17	1.35
Maximum	5.37	3.47	3.97
Std. deviation	1.02	0.63	0.77
N	26	26	20

The differential in hours per completion (the HPC ratio) takes into account the time devoted to the actual interview. The productivity differential as measured by HPC lessens somewhat compared to SRHPC, with an average HPC ratio of 2.0.

Thus, on average across all the surveys, cell phone RDD surveying took twice as long per completion as the RDD landline; i.e., the completions per hour in the cell phone surveys came in at half the rate of the landline surveys.

The cost ratios in Table 3 take into account the cost of the phone number sample and cash incentives, generally used on the cell phone side only. With these added per-complete cost increments (small for most surveys), the average cost ratio rises slightly to 2.1.

Effects of a Cell Phone Only Design. As noted above, eligibility rates in the cell phone part are notably lower if a dual-frame design requires screening for cell phone only cases and dropping those reached via the cell phone sample that have dual phone service. As shown in Table 4, all three ratios (SRHPC, HPC, and overall cost) are substantially lower when there is no screening for type of telephone service and all cell phones are considered to be qualified for inclusion on this factor. The SRHPC ratio for cell-only surveys was 3.0, contrasting with 2.3 for

[37] Two studies that reported even higher ratios were excluded as “too extreme” outliers.

all-cell surveys. The average HPC ratio was 2.4 for the cell phone side in cell-only survey compared to the companion landline survey, but 1.9 in all-cell surveys. The overall cost ratios varied in similar fashion, with the cell phone completions being roughly double the cost of landline completions in all-cell surveys, whereas they were 2.6 times the cost in cell-only surveys.

Table 4
Means for All-Cell (No Screening) versus Cell Phone Only Surveys

Type of Dual Frame Design		Screening and Recruiting Hours per Completion	Hours per Completion	Overall Cost per Interview
		SRHPC Ratio	HPC Ratio	Cost Ratio
All-cell designs	Mean	2.38	1.87	1.96
	N	20	20	17
Cell phone only designs	Mean	3.03	2.45	2.60
	N	6	6	3

Cost Effects of the Geographic Area Covered. As previously discussed, the survey eligibility rate also is affected by the geographical location of the target population. When the study area is the entire nation, people who purchase their phone in one state and move to another remain eligible, at least from a geographic standpoint. When the survey geography is an entire state, then the eligible phone exchanges can be identified readily by area code alone. However, when the study area is a county, metro area, or another location not coincident with area code or prefix boundaries, then both landline and cell phone samples are less efficient for reaching persons in the defined study area. However, the decrease in efficiency is greater for the cell phone RDD samples than for the list-assisted landline RDD samples.

Table 5 compares state and national dual frame surveys, on the one hand, and local dual frame surveys on the other, while still separating cell-only surveys from all-cell surveys. The differences in the productivity and cost ratios are relatively small, but are in the expected directions: i.e., local all-cell surveys have higher ratios than state or national all-cell surveys. The one survey that undertook cell-only calling in a local area experienced a cost ratio of 4 to 1,

indicating clearly the difficulty of finding qualified respondents on the cell phone side under such a sampling design.

Table 5
Means for Local Surveys versus National/State Surveys, by Design Type

Dual Frame Design	Geography		Screening and Recruiting Hours per Completion	Hours per Completion	Overall Cost per Interview
			SRHPC Ratio	HPC Ratio	Cost Ratio
All-cell designs	National & statewide	Mean	2.36	1.84	1.86
		N	14	14	12
	Local	Mean	2.42	1.92	2.19
		N	6	6	5
Cell phone only designs	National & statewide	Mean	3.03	2.45	1.92
		N	6	6	2
	Local	Mean	--	--	3.97
		N	0	0	1

Summary of Cost Issues in U.S. RDD Cell Phone Surveys

The survey industry in the United States now has had sufficient experience with dual frame telephone surveys combining RDD cell phone and RDD landline for production and cost ratios to be estimated from empirical data. Based on reports from a heterogeneous set of more than 30 recent dual frame RDD surveys, it can now be said with some confidence that in a typical dual frame survey using an “all-cell” design (i.e., without screening for type of telephone service), that cell phone RDD interviewing will be, on average, about half as productive (per hour) as the landline RDD interviewing, and hence about double in cost per interview. If a cell phone only design is used as the cell phone component in a dual frame design, the cell phone completions will cost, on average, approximately two-and-a-half times more than the landline completions.

Various features of a dual frame RDD survey, especially those that impact the working number rate, contact rate, eligibility rate, cooperation rate, type of dialing that can be deployed, use of advance mailings, or interview length, may cause the cost ratios between the cell phone and landline samples in that survey to vary from the ratios reported above. In particular, dual frame surveys in local areas will experience higher productivity and cost ratios than those using statewide or national sampling frames.

Putting Costs into Their Proper Context. The overall cost increment for converting a landline RDD survey to a dual frame RDD survey that includes cell phone interviewing will depend, of course, on the number of interviews that are attempted by cell phone. If a greater proportion of the interviewing effort is allocated to the cell phone RDD frame, then the overall ratio of the dual frame survey's cost (relative to the cost of a landline-only RDD design) will be higher. As has been discussed in the Coverage and Sampling section of this report, there is no current agreement on the optimal allocation of the final sample between landline RDD and cell phone RDD samples.

Readers should keep in mind that the cost of cell phone sampling must be considered within the context of optimizing the dual frame design. RDD cell phone samples in the U.S. are undertaken to improve coverage and to bring into the final sample proportionally members of groups that would (increasingly) be underrepresented in a RDD landline-only design; thereby enhancing the survey's face validity, as well as providing a more representative unweighted final sample. However, if a researcher chooses to minimize the number of cell phone completions out of a desire to minimize field costs, the survey may pay a penalty in statistical precision, because the realized sample will need to be adjusted with fairly large post-stratification weights. With a large design effect, the effective sample size may be reduced to the point where more completions are needed to achieve the desired level of precision. Interested readers should consult Benford, Tompson, Fleury, Feinberg, Feinberg, Speulda and Weber (2009) for more details on these issues and a discussion of the costs of various dual frame designs measured against the resulting effective sample sizes. (Appendix C of this report contains an updated summary presentation of this work by Benford and his colleagues.)

Electronic White Pages Sampling and Telephone Survey Costs

One intriguing alternative that is being explored by some U.S. researchers is the possibility of substituting directory-listed landline phone numbers (also called Electronic White Pages or EWP sample) for some or all of the landline RDD sample in a dual (landline and cell phone) frame design. It is well known that EWP landline samples underrepresent certain demographic groups, but by fortuitous circumstances these generally are the same groups that are fairly easily reached via a cell phone sample, so they appear to be fairly well covered in a dual frame design that combines cell phone and EWP landline samples.

A dual frame study with a EWP landline sample and a cell phone RDD sample (without screening) would cover all telephone households *with the exception of those that have an unlisted landline and no cell phone available.* An analysis of NHIS data by Guterbock and colleagues (forthcoming) suggests that coverage error from exclusion of the "unlisted-landline-only" households is likely to be very small for most survey purposes. Since interviewing from a EWP landline sample is far more cost-efficient than is interviewing from a landline RDD sample, the savings from substituting EWP landline sample for landline RDD sample can substantially offset the incremental cost of including the cell phone RDD sample. A series of recent surveys by the University of Virginia Center for Survey Research has been testing this approach in "triple-frame" studies that combine landline RDD, EWP landline, and cell phone RDD samples, with promising results.[38] In these surveys, only 2 percent or fewer of interviewed telephone households in the combined and weighted landline RDD and cell phone RDD samples report themselves to be in the "unlisted-landline-only" segment.

[38] This three-sample approach affords some cost savings over the more usual dual frame design, while not fully abandoning the more expensive, traditional landline RDD sampling frame. This design has allowed direct comparison of survey estimates drawn from combining the EWP and cell phone samples with those obtained from combining landline RDD and cell phone samples (Guterbock et al., 2009).

CONCLUSIONS AND DISCLOSURE RECOMMENDATIONS

In the past two years since AAPOR issued the first Cell Phone Survey Task Force report in 2008, a great deal has been learned about cell phone surveys in the United States. The 2010 edition of the report has incorporated what the Task Force members believe to be the key implications from the new research and from the new lessons and experiences researchers have gained while conducting U.S. cell phone surveys since 2007. Nevertheless there is a great deal that remains to be learned before researchers can proceed with complete confidence in making many important decisions about how to design and implement telephone surveys in the U.S., especially for surveys that strive to accurately measure the behaviors, experiences, cognitions, perceptions and/or attitudes of the general public.

In terms of Sampling and Coverage, good RDD cell phone samples are available for researchers to use. The cell phone RDD frame has been demonstrated consistently to provide better coverage of a number of important demographic groups in the U.S. than the landline RDD frame. However, to date, cell phone RDD samples for the U.S. are not as efficient as landline RDD samples, for many reasons. Possibly the most basic decision that researchers need to make is whether they will use a cell phone sample to supplement a landline sample and if so whether the dual frame design will be overlapping (with no screening for telephone service and usage) or nonoverlapping (e.g., screening the cell phone sample for cell phone only persons/households). The Task Force believes at this time that neither of these two basic dual frame designs is always the preferred one for researchers to choose. That may change in the next few years, but for now researchers need to think very carefully about how to best balance the many issues and implications associated with their sampling design decisions.

In terms of Nonresponse, cell phone response rates trend somewhat lower than comparable landline response rates, but the size of the gap between the rates for the two frames is closing. This is thought to be due to landline response rates continuing to drop faster than cell phone response rates. Research needs to be conducted to more fully understand the size and nature of differential nonresponse in dual frame telephone surveys and the possible bias this may be adding to survey estimates. Future research needs also to seek a better understanding of how dual service users (those with both a cell phone and a landline) can best be contacted and successfully interviewed via telephone.

In terms of Measurement, to date there is no compelling evidence that data gathered via a cell phone is consistently of lower quality than that gathered via landline. But the Task Force recommends that researchers continue to be vigilant in studying possible differences, because research to date that has found such differences trends in the direction of slightly lower quality resulting from the cell phone respondents under various circumstances. Furthermore, there are many logical reasons to anticipate that there are factors that threaten the quality of some of the data gathered from cell phone respondents, especially when they are interviewed away from home and/or when they are engaged in other distracting behaviors while being interviewed.

In terms of Weighting, there is no single approach to weighting dual frame surveys that the Task Force advises all telephone researchers to follow. As discussed in the section on Weighting, there are many considerations researchers need to take into account when deciding how best to weight their dual frame and single frame telephone samples. The Task Force notes that weighting U.S. national telephone surveys is likely to be a less complex and more effective process than weighting non-national surveys due in part to the limited range of variables for which accurate populations parameters exist at non-national levels. The Task Forces urges all researchers to be forthcoming in disclosing the decisions they make about weighting their telephone samples, including possibly deciding not to weight.

In terms of Legal and Ethical Issues, the Task Force affirms that U.S. cell phone numbers should be manually dialed unless a survey organization has gained expressed prior consent from the cell phone owner. The Task Force also encourages researchers to carefully consider various ethical implications related to respondent safety and privacy, the number and frequency of callbacks, and remuneration that may be offered to cell phone respondents.

In terms of Operations, survey firms are urged to review all production systems that are used to call and gather data from respondents reached on a cell phone. This includes (1) the scripts that are used to screen respondents for various forms of eligibility, (2) how interviewers are trained to gain initial cooperation so as to screen those reached on their cell phone, (3) how interviewers are trained to gain cooperation from eligible cell phone respondents, (4) how interviewers are trained to gather data from cell phone respondents, and (5) how interviewers are assigned to cell phone samples. Survey organizations without adequate experience conducting cell phone surveys should recognize the need to carefully plan how their interviewers who will work cell phone samples are trained and assigned.

In terms of Costs, cell phone completions generally have been found to be approximately twice as expensive as otherwise comparable landline completions, and sometimes they are upwards of four times as expensive, e.g., when nonoverlapping dual frame designs are required, especially those that are non-national in scope. There are many reasons that these additional costs are incurred, as discussed in the text of the report. Researchers are urged to think carefully about the true "costs" of the decisions they make about their sampling design and how they divide the number of final completions a survey will achieve between the cell phone and landline frames. This includes cost implications of a dual frame survey's weighting, design effects and effective sample size.

Disclosure Recommendations

As can be seen in this report, despite the new information that has been learned about how best to conduct good quality and cost-efficient cell phone surveys in the U.S. in the past two years, a good deal of very important new research remains to be conducted before telephone survey researchers can conduct RDD surveys of persons reached on their cell phones with full confidence in the findings that reasonably is expected by the users of those data.

In light of this, there are few recommendations the Task Force believes can be made with confidence at this time. However, as a result of the developments discussed in this report and as an important step in applying survey methods to cell phones in the U.S., the Task Force recommends the following disclosure-related recommendations:

1. All telephone surveys should disclose whether or not the sample includes only landline numbers, only cell phone numbers, or both, and how the numbers were selected from their respective frames.

   RDD surveys without a cell phone augmentation should include in their methods report and in the survey information that accompanies published findings (i.e., fielding date, response rates, margin of sampling error, etc.) that "persons residing in households with no landline telephone are not included in the results." If researchers believe that they have produced unbiased estimates without the cell phone only segment, this belief and

the reason for it should be directly discussed in the report of findings, because the topic is no longer ignorable and should not be lightly dismissed.[39]

2. All RDD telephone surveys with samples that contain cell phone numbers should fully disclose how any weights have been constructed and what population/universe estimates have been used to post-stratify, recognizing that many such parameters are not available at subnational levels and may not be very accurate even when estimates are available.

3. RDD telephone surveys targeting subgroups in the U.S. with substantial percentages of adults who live in cell phone only households (e.g., 18- to 29-year-olds; renters; and those below the poverty threshold) should sample cell phone numbers or, if this is not feasible, discuss how excluding cell phone numbers may affect the results.

These recommendations further two goals already explicit in AAPOR's Standards and Best Practices for Survey Research – (a) selecting samples that well represent the population to be studied and (b) disclosing all methods in order to promote evaluation and replication. These recommendations also are fully consistent with AAPOR's Transparency Initiative. Furthermore, the Task Force believes that adhering to these disclosure standards will aid in the interpretation of RDD telephone survey results in the U.S., both in general and during the 2010 election cycle.

[39] Post-stratification weighting in landline RDD surveys, while more stressed for young adults, minorities, low income groups, etc., may correct the demographic picture for the absence of cell-only groups for the subject under study but may not redress what is potentially an unknown bias. When a landline only RDD survey is being proposed, the cell phone only population that will be excluded should be described as much as possible to evaluate the impact on generalizing the survey findings. Just as nonresponse is better understood with a follow-up nonresponse study, perhaps some level of cell phone only study should also be proposed for what it might reveal or suggest (assuming a full cell phone only compliment is not affordable for the main study). Clearly, with nonresponse issues and cell phone only issues co-existing in landline RDD surveys, to examine these with even modest nonresponse and cell phone only studies will increase costs. This means that the cost of landline RDD surveys that cannot afford to add a full cell phone frame component can only go up if researchers want some minimal insight into nonresponse and noncoverage to evaluate the quality of any landline only RDD survey.

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GLOSSARY

1000-banks or 1000-blocks	See “Telephone Number Components.”
100-banks or 100-blocks	See “Telephone Number Components.”
Area Code	See “Telephone Number Components.”
Autodialer	An electronic device that can automatically dial telephone numbers to communicate between any two points in the telephone network. Once the call has been established the autodialer can provide verbal messages or transmit digital data (like SMS messages) to the called party. A predictive dialer is a computerized system that automatically dials batches of telephone numbers for connection to interviewers or telemarketing agents. They can also reject numbers that do not make a connection. Predictive dialers are widely used in call centers. The FCC has placed a variety of restrictions on the use of such devices, including a general prohibition that such computerized equipment cannot be used by anyone to initiate calls to wireless devices (cell phones, pagers, etc).
Bellcore	See “Telcordia/Bellcore.”
Cell Phone	A generic term for a portable wireless electronic device used for wireless communication. Current cell phones can support many additional services such as SMS for text messaging, e-mail, packet switching for access to the Internet, and MMS for sending and receiving photos and video. Outside the United States these devices are commonly referred to as mobile phones.
Cellular	A form of wireless communication where wireless telephone calls connect to a cellular network of base stations (cell sites), which is in turn interconnect to the public switched telephone network. Cellular phones operate in the 824-894 MHz frequency range. Originally, cellular licensees were required provide analog service in addition to digital service, but this requirement ended on February 18, 2008. As cellular licensees have converted from analog service to digital service they have generally adopted the GSM standard for mobile phones allowing them to compete with PCS licensees. See “Cell Phone,” “Personal Communications Service (PCS),” “Wireless” and GSM.
Dual Frame Sampling	Occurs when a sample is selected from two potentially overlapping frames. For example, a sample of listed telephone numbers supplemented with a RDD sample. The overlap, units that appear in both frames, must be identified and accounted for.

Exchange

See “Telephone Number Components.”

GSM

GSM stands for Global System for Mobile communications or *Groupe Special Mobile*. GSM uses a cellular network and is the most popular standard for mobile phones in the world today. GSM phones can operate in three or four different frequency bands including cellular and PCS bands. This flexibility allows subscribers to use their phones in many places around the world. GSM phones require SIM (Subscriber Identity Module) cards. These removable or interchangeable cards store a subscriber’s subscription information and allow users to change phones by simply switching the SIM card from one mobile phone to another or switching SIM cards on a single phone. The ability to switch SIM cards is currently blocked by carriers in the United States. See “Mobile Phone,” “Cell Phone,” “Cellular” and “Personal Communications Service (PCS).”

Mobile Phone

Mobile is the common term used outside of the United States and Canada to refer to wireless services or wireless phones. In the United States and Canada, the term Mobile Service is used by the telecommunications industry to refer to Improved Mobile Telephone Service (IMTS) which is a pre-cellular, low frequency VHF/UHF radio system. IMTS operates in low bands (35-44 MHz, 152-158 MHz and 454-460 MHz). Satellite, Cellular and PCS systems have replaced residential IMTS for most residential use. Some businesses still use IMTS radio systems to support their business. Today only a handful of exchanges and 1000-blocks are classified as Mobile. Exchanges classified as Mobile (NXX Type 01) are normally excluded from wireless frames. See “Cell Phone,” “Cellular,” “Personal Communications Service (PCS)” and “GSM.”

Neustar

Neustar provides a variety of telephone numbering services to the telecommunications industry. They are currently the Number Portability Administrator and maintain the databases associated with ported numbers, the relationship between the number kept and the new switch to which that number has been ported. As the North American Numbering Plan Administrator, Neustar controls the assignment of area codes and prefixes, and as the National Pooling Administrator controls the assignment of thousand-blocks as required by thousand-block pooling.

Neustar maintains databases of all ported numbers: wireline (landline) to wireline, wireless (cellular) to wireless, wireline to wireless and wireless to wireline. The wireline to wireless database is critical in the process of identifying cellular telephone numbers within the landline RDD frame, especially given the number of people porting their home wireline telephone number to a cellular number continues to grow. These databases are updated daily and there is a license fee to access them.

NXX Type

NXX Type is a term and set of two-digit codes used by Telcordia and communications carriers to define the type of telephone service provided in an exchange or 1000-block. See "POTS," "Cellular," "Personal Communications Service," "Shared Service," "Special Billing" etc.

Personal Communications Service (PCS)

The name of the broadband wireless or cellular service that uses the 1850-1910 MHz and 1930-1990 MHz radio bands for digital mobile phone services in Canada and the United States. PCS services include both voice and advanced two-way data capabilities that are generally available on small, mobile multi-function devices. Code Division Multiple Access (CDMA) and GSM systems use the PCS frequencies.

The FCC set aside the frequency band of 1850-1990 MHz for mobile phone use in 1994, as the original cellular phone band at 800-894 MHz was becoming overcrowded. Sprint was the first company to set up a PCS network, a GSM-1900 network. Sprint upgraded to CDMA technology and sold their GSM infrastructure to Omnipoint, which later became part of T-Mobile USA. Today many broadband PCS licensees (including the major players (Sprint/Nextel, T-Mobile, Cingular/AT&T, US Cellular, and Verizon) offer PCS services in competition with existing cellular licensees.

POTS

Old Bellcore/Telcordia acronym for "Plain Old Telephone Service," or telephone service carried over landlines as opposed to the airwaves (wireless).

Predictive Dialer

See "Autodialer."

Prefix

See "Telephone Number Components."

Random Digit Dialing (RDD)

A method of reducing sampling frame error that involves the use of randomly generated numbers for a telephone survey, instead of relying on telephone directories or other lists of numbers that may exclude certain types of consumers.

Shared Service

A Shared Service exchange or 1000-block is one in which the service provider may provide more than one type of service in that exchange or 1000-block. For example NXX Type "Shared POTS and Cellular" designates an exchange or 1000-block in which the service provider may be providing both POTS and cellular service.

Special Billing

Some exchanges and 1000-blocks have an NXX Type defined as "Special Billing." According to Telcordia, "there may be line numbers or thousands blocks assigned to a Service Provider who has requested a Local Exchange Carrier Intra-LATA special billing option on a LATA-wide basis or on a SELECTIVE exchange basis."

These special cases appear to involve areas where Intra-LATAs

calls may cross state lines and may therefore require special billing procedures.

Suffix

See “Telephone Number Components.”

Telephone Number Components

Telephone Number Components:

North American Numbering Plan is the integrated telephone numbering plan covering the United States and its territories, Canada, Bermuda, and 16 Caribbean nations. It is a system of three-digit numbers.

Area Code is the term associated with the first three digits of a 10-digit telephone number that allows communications networks to direct telephone calls to particular regions on the network where they are further routed to local networks. It is also known as the NPA or Numbering Plan Area. An area code can cover an entire state or a city or part of a city. In certain areas of the plan, multiple area codes can service the same area (overlays).

Prefix is the term associated with the second set of three digits of a 10-digit telephone number. This set of numbers allows communications networks to direct calls to more local areas within the larger area code. Each prefix has been assigned to a single Telephone Operating Company, a company that has been licensed by the FCC to provide telecommunications services over the Public Switched Telephone Network. Every prefix has 10,000 possible phone number combinations (0000-9999).

Suffix is the term associated with the final four digits of a 10-digit telephone number. This set of numbers allows communications networks to direct calls to the switch associated with the end user. The suffix can be further segmented into blocks or banks of consecutive numbers.

1000-blocks or 1000-banks are blocks of 1,000 consecutive suffix numbers starting with the same digit (0000-0999). Within a prefix, 1000-blocks can be assigned to telephone operating companies other than the company responsible for the prefix.

100-blocks or 100-banks are blocks of 100 consecutive suffix numbers starting with the same two digits (1100-1199). Analysis of listed telephone numbers in 100-blocks is used to create list-assisted telephone frames.

Exchange is a term that is frequently used in place of the term prefix, but an exchange is actually the geographic area serviced by a prefix or set of prefixes. For , 203-929 and 203-926 are two of the many prefixes that service the Huntington, Conn., exchange area. Prefixes are numbers, but exchanges are usually associated with a place name such as Huntington, Conn. Exchanges usually have a

	single building where all the wires in all the prefixes come together and from which calls are directed to and from users in those prefixes. A set of geographic coordinates associated with this building have traditionally been used to determine calling areas and the cost of making a phone call (local vs. long distance). For this reason, exchanges are sometimes referred to as Billing Centers or Rate Centers or Wire Centers. In prefixes that have multiple service providers and different types of service (POTS+cellular+broadband) individual 1000 blocks may have place names and rate center coordinates that are different from those associated with the prefix.
Text Messaging	A telecommunications protocol that allows the sending of "short" (160 characters or less) text messages, person-to-person messaging. It is available on most digital mobile phones and some personal digital assistants with wireless telecommunications. The individual messages that are sent are called text messages, SMSes, texts or txts.
VoIP	Voice over Internet Protocol. VoIP providers basically reroute phone calls over the internet. VoIP service (cable, DSL, etc.) is still primarily landline service and VoIP numbers are normally assigned in landline prefixes. VoIP companies provide a special modem connected to the internet into which the subscribers plug a regular landline phone. Some wireless carriers offer VoIP using a specially equipped cell phone assigned a number from their set of cellular prefixes. Thus it appears that VoIP is not a separate mode but can be incorporated in either service. Subscribers can keep their existing phone number and switch it to VoIP (i.e. port their number). Under certain circumstances they may be able to keep their VoIP number when moving to a different area code and get an in-bound telephone number from a different area code through the use of what is commonly referred to as a virtual phone number. Thus there is a potential loss in geographic precision that is also characteristic of cell phone numbers without VoIP. Not all VoIP providers allow their subscribers to “list” their telephone number in a directory or make their telephone number available through Directory Assistance. This means that list-assisted RDD may underrepresent exchanges and 1000-blocks assigned to VoIP services. At the moment there are no indications of subscribers treating their VoIP phone differently than they would treat a landline or cellular phone. For this reason VoIP numbers can be dialed as regular landline or cell numbers.
Wireless	Is a telephone connection where communications travel through the airwaves rather than over wire or fiber optic cable. This term is regularly used in the telecommunications industry, particularly by government agencies, when referring to non-landline telephone service and includes cellular, PCS, Mobile and Paging services.

	See “Cellular” and “Cell Phone,” “Mobile Phone,” “Personal Communications Service (PCS)” and “GSM.”
Wireline	Synonymous with “landline”. Is regularly used in the telecommunications industry, particularly by government agencies, when referring to landline telephone service.

APPENDIX A

Address-Based Sampling (ABS) as an Alternative to Sampling Cell Phone Exchanges

Given the challenging issues related to cell phone sampling, some researchers have begun to explore other sampling options that altogether forego the use of telephones as a primary sampling unit (Link et al. 2006; Link et al. 2008; Steve et al. 2007). The growth in database technology has allowed the development and maintenance of large, computerized address databases, which may provide telephone survey researchers in the U.S. with a cost-effective address-based sampling (ABS) alternative to RDD for drawing representative household samples.

To date, address databases compiled based on the Delivery Sequence File (DSF) of the U.S. Postal Service (USPS) have proven most promising. Since the USPS is prohibited from selling or leasing addresses, access to the USPS files is carefully controlled through licensing. The USPS offers a variety of products and services known as Address Management Services (AMS) that allow licensees to improve the quality of their lists. Most of the companies that do list compiling have a DSF license that only allows them to standardize and validate addresses on their list. AMS also provides full access to a weekly snapshot of their Computerized Delivery Sequence (CDS) file to qualified list owners specially licensed by the USPS. Two such vendors are Valassis (formerly ADVO) and Compact Information Systems (CIS). These vendors in turn may license the resulting lists to other list vendors for research and commercial applications. The CDS file contains all delivery point addresses serviced by the USPS, with the exception of general delivery (USPS, 2009).[40] Each delivery point is a separate record that conforms to all USPS addressing standards, thereby facilitating the drawing of area probability samples of postal addresses from any geography within the U.S. using the same file structure.

Benefits of ABS. From a sampling perspective, ABS provides a very high level of coverage, with some estimates placing frame coverage of U.S. residential postal households in the mid-90 percent range. As such, ABS provides an alternative way to sample and reach cell phone only and other cell phone households without having to sample them from cell phone exchanges. The frame also provides coverage of traditional landline households as well as providing access

[40] The USPS defines *general delivery* as "An alternate delivery service that allows customers with proper identification to pick up mail at post offices. Provided primarily at offices without letter carrier delivery or for transients and customers who do not have a permanent address or who prefer not to use post office boxes." (**http://www.usps.com/cpim/ftp/pubs/pub32.pdf**

to households with no telephone and newly emerging VoIP-only based computer telephones – groups that heretofore have been underrepresented in traditional RDD telephone survey methods. Additionally, because addresses are in a fixed location, telephone portability is not an issue and sample selection can be conducted with much more geographic precision than can sampling from cell phone exchanges. In particular, geographic eligibility within the sampled target area in ABS typically does not require the onerous and unreliable screening that non-national cell phone surveys may require.

Another important benefit of using an ABS frame is the rich amount of auxiliary information that can be matched to an address, facilitating more complex sample designs and providing information for enhanced contacting and recruiting approaches. Perhaps most importantly, the last name of the "head of the household" can be retrieved for the vast majority of addresses, and in turn, a majority of such addresses can be matched to a landline telephone number via commercial databases, thereby facilitating multiple potential modes of contact with many of the sampled households. In addition to matching landline telephone numbers to addresses, survey sample vendors also can provide case level variables such as Spanish surname indicator for the household head, her/his likely age, as well as geocoding and attachment of census tract information such as the percentage of racial/ethnic groups within a particular local geography, median household income of the area, and in some cases even e-mail addresses. These variables can be used in a number of ways to enhance the survey design, such as through sample stratification on key variables, advance mailings to households, and tailoring of materials, contact scripts, or incentives based on household characteristics such as likely age, race, or ethnicity of the head of household. Moreover, such supplementary data elements can provide valuable enhancements for analytical applications by providing information beyond what a survey can secure. In particular, this will enable survey research to conduct nonresponse bias investigations as such data items will be available for both respondents and nonrespondents.

Implementation of ABS. In terms of survey operations, telephone researchers have tended to choose one of two main approaches to use ABS to reach cell phone only households: (a) sampling and attempting interviews with households from the entire sample or (b) screening to identify cell phone only (or sometimes including cell phone mostly) households. In this respect, the survey designs using ABS mirror those used when sampling directly from cell phone sample frames. With either approach the process used most often involves three steps:

(1) Drawing a random sample of addresses from the target area;

(2) Matching the addresses to directory listed and commercially available telephone numbers – with the assumption that these will be (nearly) exclusively landline numbers (given that list vendors are prohibited from knowingly providing matches to cell phone numbers); and

(3) Surveying just the "unmatched" portion of the sample by mail or in-person to contact cell phone only homes.

Survey contact can be carried out in one or two stages. With a one-stage approach, the only cost-effective contact mode is via the mail. Researchers can either send a hardcopy questionnaire or direct respondents to self-initiate a Web survey, call-in survey, or telephone-audio computer-assisted (TACSI)/interactive voice response (IVR) survey. With a two-stage approach, an attempt is made to collect a contact telephone number from the sampled address. Again, initial contact is limited to mail for cost reasons, but the future contact information can be collected by various other modes as described previously. Households that return a valid telephone number, be it landline or cell phone, can then be contacted by telephone interviewers if a more traditional CATI survey is being used. Note that because the respondent is willingly providing their number as their preferred contact number (and the numbers are not obtained through database matching), the legal restrictions on the use of autodialing cell phone numbers in the U.S. do not apply.

In terms of cost, a given number of sampled addresses for ABS are about twice as expensive as a comparably sized sample of telephone numbers. However this can vary broadly based on the sample vendor, total number of cases sampled, and amount of additional data appended to each sampled case. In terms of total survey cost, however, the cost of obtaining an address per sampled ABS unit is minimal. Additionally, because of the efficiency of the ABS frame (i.e., there are relatively few nonresidential addresses if prescreening is conducted by the sample vendor), far fewer addresses (than telephone numbers) are needed in the designated sample in order to reach the requisite final sample size of residential households.

Drawbacks of ABS. Address-based approaches do, however, have some drawbacks. For example, the quality and completeness of the address information obtained from the commercial vendors varies widely depending on (a) how often the vendor updates the listings,

(b) the degree to which the listings are augmented with information from other databases, and (c) whether the vendor purges the records of householders who request that their information not be released (Link et al. 2006). Vendors also differ in their experience with and ability to draw probability samples from the DSF list, which can be problematic if researchers do not wish to draw their own samples. The DSF contains post office (P.O.) box and multi-drop addresses (multiple persons and/or unit numbers associated with a single delivery point address), which may be problematic for in-person and telephone surveys where a street address including apartment number is required to locate the household or an associated telephone number. Such addresses may be less problematic for surveys that use mail as the recruitment mode (such as with mail or Web surveys). Households with multiple mailing addresses (e.g., a street address and a residential P.O. box) introduce selection multiplicities in mail surveys. In some areas, households with a P.O. box address do not receive home mail delivery. This circumstance may be more prevalent in rural areas where a P.O. box may be provided at no cost and no home mail delivery is made. Thus, including P.O. boxes may be necessary to ensure coverage of all households.

From an operational perspective, ABS often limits the ability of a research organization to conduct quick turnaround studies. Although a majority (more than 60 percent) of the sampled addresses can be matched to a telephone number, the remaining 40 percent must be contacted/recruited first by mail (or in-person) regardless of the actual survey mode used for data collection. This process takes time (and can be quite expensive). As an alternative, an organization can conduct on-going prerecruitment efforts with these “unmatched” cases (i.e., those with no matched telephone number), obtaining telephone contact information from respondents and providing a ready bank of numbers from which to sample for this portion of addresses. This is, however, a relatively expensive and somewhat complex proposition.

If limited to mail only, many ABS surveys would also need to be adjusted in terms of complexity, as complex surveys (i.e., those with complex skip patterns and ones that use various randomizations of item wording and ordering) are not readily feasible with a paper-and-pencil approach. Use of a Web survey option and/or a call-in number to a CATI interviewer can alleviate this problem. However, only households with Web access would be able to use the former approach and relatively few respondents are likely to call in to complete a survey with the latter design.

Appendix A References

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APPENDIX B[41]

This appendix includes examples of the questions used by several major survey organizations for the purposes of weighting cell phone samples.

This appendix should *not be considered an endorsement* of these questions, but rather is offered as a resource to researchers looking for examples.

NATIONAL HEALTH INTERVIEW SURVEY	PEW RESEARCH CENTER	CALIFORNIA HEALTH INTERVIEW SURVEY	BRFSS	GALLUP	ORC MACRO INTERNATIONAL
Face-to-face interview	Telephone interview Overlap design – questions asked near end	Telephone interview Overlap design – questions asked near end	Telephone interview Screening approach for cell only	Telephone interview Overlap design – most questions asked near end	Telephone interview
Asked of people who can be reached by Landline					
			Do you have a cell phone for personal use? Please include cell phones used for both Business and personal use.	How many different residential phone NUMBERS do you have coming into your household, not including lines dedicated to a fax machine, modem, or used strictly for business purposes? Do not include cellular phones.	
Do you or anyone in your family have a working cell phone?	Do you have a working cell phone? (If no/dk) Does anyone in your household have a working cell phone?	Do you have a working cell phone?		(If zero) Is this a cell phone-only household without any telephone landlines? (If more than one) Do you have a working cell phone?	In addition to your residential landline telephone, do you also use one or more cell phone numbers? How many?

[41] The Task Force thanks Leah Melani Christian of the Pew Research Center for helping to compile most of the information in this Appendix. The Task Force also thanks each of the organizations listed in the table in this appendix for providing access to the wording of their survey items.

NATIONAL HEALTH INTERVIEW SURVEY	PEW RESEARCH CENTER	CALIFORNIA HEALTH INTERVIEW SURVEY	BRFSS	GALLUP	ORC MACRO INTERNATIONAL
How many working cell phones do you or people in your family have?					
Asked of people who can be reached by Cell Phone					
				First, to confirm, have I reached you on your cell phone?	Including the one you are currently on, how many cell phones do you own for receiving calls?
Is there at least one telephone INSIDE your home that is currently working and is not a cell phone?	Is there at least one telephone INSIDE your home that is currently working and is not a cell phone?	Is this cell phone your only phone or do you also have a regular telephone at home?	Do you share a cell phone for personal use (at least one-third of the time) with other adults?	(If reached on cell phone) In addition to a cell phone, do you also have regular landline telephone service in your home? Do you use that landline telephone to make and receive calls, or is it ONLY used for other purposes, such as connecting to the Internet, connecting to a fax machine, or for business purposes?	In addition to your cell phone, is there at least one telephone line inside your home that is currently working and is not a cell phone? Do not include telephones only used for business or telephones only used for computers or fax machines? How many?
			Do you usually share this cell phone (at least one-third of the time) with any other adults?	Is the CELL PHONE I have reached you on mainly used for personal use, or only for business purposes?	
				(If not reached on cell) Which of the following best describes you? I only have a landline phone in my household and no cell phone I have both a landline and a cell phone I only have a cell phone	(If household selection used on the cell phone) Does anyone else receive calls on this cell phone? How many adults aged 18 and over receive calls on this cell phone?

NATIONAL HEALTH INTERVIEW SURVEY	PEW RESEARCH CENTER	CALIFORNIA HEALTH INTERVIEW SURVEY	BRFSS	GALLUP	ORC MACRO INTERNATIONAL
To determine relative usage for dual users					
Of all the telephone calls that you or your family receives, are … All or almost all calls received on cell phones Some received on cell phones and some on regular home phones Very few or none on cell phones	(Now thinking about all the people in your household, including yourself,) of all the telephone calls that (you/your household receives), are … All or almost all calls received on cell phones Some received on cell phones and some on regular home phones Very few or none on cell phones	Of all the telephone calls that you receive, are … All or almost all calls received on cell phones Some received on cell phones and some on regular phones Very few or none on cell phones	Thinking about all the phone calls that you receive on your landline and cell phone, what percent, between 0 and 100, are received on your cell phone?	Of all the telephone calls that your household receives, All or almost all calls are received on cell phones Some are received on cell phones and some on regular phones Very few or none received on cell phones	Of all the telephone calls that you receive, are … All or almost all calls received on a cell phone Some received on a cell phone and some on a regular landline phone Very few or none received on a cell phone

APPENDIX C

Considerations for Sample Design, Estimates, Weighting and Costs[42]

Dual frame RDD landline and RDD cell sample designs, whether overlapping or screened for cell phone only (CPO) have two types of costs associated with them:

- Financial costs, that is, the sum of the costs of landline interviews plus the sum of the costs of the cell phone interviews; and

- Statistical "cost" in the precision of estimates due to the effects of weighting.

This Appendix is based on the work of Benford et al. (2009), using the results of polls conducted by GfK for the Associated Press (AP) – the *AP-GfK Poll*. It is presented here as documentation of a sample cost allocation model when using dual frame landline RDD and cell phone RDD surveys. The purpose of the Appendix is to illustrate the implications of sampling design decisions concerning the proportion of final sample that comes from each RDD frame when predetermined levels of precision are important.

Cost Allocation Model

Conventional thinking depicts the cost of completing interviews via a cell phone frame at some ratio to the cost of a landline interview. For example, the cost per interview (CPI) by cell phone might be two times that of the landline CPI. But it needs to be recognized that this ratio of costs varies. For example, a 10-minute interview might be twice the CPI in the cell frame versus the landline CPI but this ratio is generally smaller for a 15-minute interview. This is because the costs of cell phone interviews are incremental in nature.

Assuming that the core questionnaire content is the same regardless of frame, incremental costs are found in the cost of additional screening questions necessary for those contacted on a cell phone; and the cost of additional questions that are needed to gather information for the distribution of a reimbursement, the cost of the reimbursement, and the other cost differentials in the cell phone versus landline samples. The choice to screen for CPO persons is an additional

[42] The Task Force thanks Robert Benford of GfK Custom Research North America for contributing this updated summary of the cost information provided in Benford et al. (2009).

incremental cost. Contact rates, cooperation and other sample disposition rates differ by cell frame and landline as well, and these may be thought of in terms of a ratio. Thus, a cost model that covers variants in interview length or population members is complex with core fixed costs, incremental costs assigned to the cell frame interviews, and variable costs between the two sample types. However, the ratio in one design to another makes understanding sample frame design decisions easier to comprehend.

As an example, AP-GfK polls typically average about 15 minutes for the landline interview. Additional costs associated with cell phone completions result in a ratio of 1.8:1, cell phone CPI to landline CPI. Further, we also estimated the incremental costs of screening for CPO persons and get a ratio of 2.9:1. These ratios lend themselves to allocation models for these two types of designs.

If we start with a landline RDD interview, the cost can be expressed as the final sample size times the cost of obtaining each interview with *n* as the final sample size and C as the cost per interview:

$$n_{\text{landline}} * C_{\text{landline}}$$

Costs for obtaining interviews from a cell phone RDD frame are higher due to higher sample cost, manual dialing, asking additional questions to ascertain safety and age, and offering a re-imbursement along with collecting the relevant information and processing reimbursements.[43] Our experience indicates that the cost of a cell phone interview is a little less than double a landline interview. Conceptually then the total cost of the dual frame design is:

$$(n_{\text{landline}} * C_{\text{landline}}) + (n_{\text{Cell phone}} * 1.8C_{\text{landline}})$$

Although this might be useful to compute the total cost, another approach is to understand the difference in cost from a base of landline cost. Total cost then is dependent on the allocation of sample[44]. To understand the relative cost of our design decision we substitute *n* for each sample frame with the portion of sample allocation. This is A for landline and 1-A for cell frame:

$$((A)(C_{\text{landline}})) + ((1\text{-}A)(1.8C_{\text{landline}}))$$

[43] Reimbursement in the AP-GfK survey is $5.
[44] Costs in these examples do not include project management and statistical support in developing weights and estimation.

If A = 1 then the cost is entirely that of a landline sample and, conversely, if A = 0 then the cost is entirely that of a cell phone sample.

In 2010, AP-GfK polls are allocated as 70 percent landline and 30 percent cell phone. This dual frame design then is 24 percent more expensive than landline only sample of similar size would cost. This is shown by:

$$(0.70C_{landline}) + (0.30) * (1.8C_{landline}) = 1.24C_{landline}$$

Similarly, if we screen for CPO, we estimate that the CPO design is approximately three times the cost of a landline interview.[45] If we set CPO at 13 percent of the total final sample, then the cost of this design decision is 25 percent greater than a landline only sample of similar size:

$$(0.87C_{landline}) + ((0.13)\ 2.9C_{landline}) = 1.25C_{landline}$$

A 50 percent landline, 50 percent cell phone frame design without screening is 40 percent more than a similar-sized landline only design:

$$(0.50C_{landline}) + ((0.50)\ 1.8C_{landline}) = 1.4C_{landline}$$

A comparable coverage solution to the 50/50 dual frame is to sample CPO proportionate to population estimates at 21.6 percent[46] which is:

$$(0.784C_{landline}) + ((0.216)\ 2.9C_{landline}) = 1.41C_{landline}$$

This may be a useful way to understand the relative cost of sample design decisions in contrast to traditional landline designs.

However, these decisions may also need to be put in the context of efficiency, as shown in the Table C-1. This table, based on six AP-GfK polls in 2010 with dual frame overlapping sample design, is an updated version of Table 7, in Benford et al. (2009).

[45] A large part of the cost of screening for CPO is related to how simple or how complex the approach to the screening of this population is, i.e., number of questions to define a person as CPO.
[46] MRI Fall 2009 estimate of cell phone only

Table C-1 Comparison of Efficiencies, Relative Costs, Effective Sample (n=1,000[47])					
	Efficiency[48]	Relative Cost to Landline	Effective Sample Size	Ratio of Effective Sample to Landline	Weighted Cost for Effective *n*=1,000
Landline only	0.456	1.00	456	1.00	2.15
CPO w/landline	0.514	1.25	514	1.12	2.43
Dual 70/30	0.491	1.24	491	1.08	2.53
Dual 50/50	0.605	1.40	605	1.35	2.31
$CPO_{proportional}$	0.522	1.41	522	1.18	2.70

The updated table shows the importance of accounting for precision needs or tolerances around estimates based on design decisions and when weights are used to approximate unbiased estimates. Although landline samples are the least expensive, they result in the least amount of effective sample size.[49]

If, for example, precision is needed at +/-3.1 percent at the 95 percent confidence level, then effectively, a final sample of 1,000 is needed. Aside from dampening the variability through trimming weights to lift the effective sample size, which would affect each design comparably, collecting a larger unweighted sample to achieve the desired effective sample size can be considered. The last column on the right in the table shows the adjusted costs to achieve this goal, computed as 1,000 divided by the effective sample size times the relative cost to landline. Although the landline, with all its coverage issues, is still the least expensive, the "best buy" is a dual 50/50 design given that design has the next lowest weighted cost to achieve an effective *n* = 1,000.

[47] Data are actual and modeled from six AP-GfK Polls in 2010 reflecting the dual 70 percent landline RDD and 30 percent cell RDD design currently in use.
[48] Efficiency is 1 divided by the design effect or can be computed as the sum of the weights divided by the sum of the squared weights.
[49] The effects of weighting on effective sample size vary between these surveys and will vary across other types of surveys. Results will vary for many reasons, including the choice of variables used in the weighting scheme and the degree to which various groups are underrepresented in the realized subsamples. However, it is expected that similar sample designs to those discussed here would produce similar directional differences in effective sample size due to landline RDD's undercoverage of younger adults and other demographic subgroups. Details of the weighting in this analysis can be found at http://www.apgfkpoll.com/methodology.html. As a quick overview, weights are computed using a pre-weight that includes probabilities of selection and a mixing parameter and then raked to age by sex, race as black and all other races, Hispanic and non-Hispanic, and educational attainment all determined from the CPS and census region by phone service per Media Research & Intelligence's fall 2009 wave.