

**SC&A Status Update: SEC-00219**  
**Evaluation of Areas and Times that**  
**NIOSH has Determined Doses are**  
**Reconstructable**

John Stiver

S. Cohen and Associates

Contractor to:

Advisory Board on Radiation and Worker Health/ABRWH  
Centers for Disease Control and Prevention

July 23, 2015

# Introduction and Background

- Due to the complexity of the INL, the Advisory Board determined that its review of the ER should be performed in a graded manner, whereby SC&A would first conduct a preliminary review of certain issues of most immediate concern to the Board.
- SC&A near-term tasking to support the July 8, 2015, Work Group (WG) meeting and the July 23, 2015, Advisory Board session:
  - Evaluate the proposed class definition and also begin a focused evaluation of the areas, activities and times for which NIOSH has determined that doses are reconstructable with sufficient accuracy
- This review, in addition to being preliminary due to time constraints, is also very much a work in progress.
- This presentation is strictly to inform and recommend areas where we believe more research/investigation is needed. **No judgments or conclusions are being drawn at this preliminary stage.**

# Introduction and Background (cont'd)

## Dose Reconstructability/Gap Analysis

- Approach: “Horizontal” and “Vertical” analysis
  - Horizontal – examine the DR methodology applied by NIOSH for all INL personnel – cross cutting
  - Vertical – specific characteristics of the individual areas at the INL site
- 6 areas of investigation:
  1. Fission and Activation Product (FAP) Bioassay Indicator Radionuclides (horizontal)
  2. Reactor Modeling (horizontal)
  3. Burial Grounds (vertical)
  4. Central Facilities Area (CFA) (vertical)
  5. Chemical Processing Plant (CPP) Pre-1963 (vertical)
  6. Test Area North (TAN) (vertical)

# FAP and Actinide (Pu, U, etc.) Intakes per NIOSH's SEC ER

**SEC ER: 4 Fundamental assumptions form the basis for NIOSH's ability to reconstruct internal doses**

- 1. FAP Bioassays** – Sufficient workers' records containing FAP bioassay (in-vitro and in-vivo) results are available to assign intakes and resulting doses from FAP (some periods/areas may need an FAP coworker model developed).
- 2. FAP Intakes** – Except for special situations, all the dosimetrically significant FAP intakes are directly tied to an indicator radionuclide (Sr-90 or Cs-137). The FAP ratios and intake assignment methods provided in ORAUT-OTIB-0054 bound all FAP exposure potentials at INL.

# FAP and Actinide (Pu, U, etc.) Intakes per NIOSH's SEC ER (cont'd)

- 3. Actinide Intakes** – Except for special situations, the actinide (uranium, plutonium, thorium, etc.) intakes are directly tied (in a constant ratio) to the FAP; therefore, actinide intakes and resulting doses can be assigned using Table 5-22 (Sr-90 ratios) and/or Table 5-23 (Cs-137 ratios) of ORAUT-TKBS-0007-5 (TBD-5).
- 4. Special Situations Actinides** – Personnel involved in operations and situations (planned or unplanned) with actinides present, that were not directly tied to an FAP in a constant ratio, were adequately monitored, and the results are available in the workers' records. Therefore, actinide intakes and resulting doses can be reconstructed in these special cases.

# SC&A's Approaches to Evaluate NIOSH's Methods

- **SC&A has evaluated Assumptions 2 and 3**
  - SC&A evaluated the ratio methodology used by NIOSH by employing three different strategies
    1. **NOCTS** – Evaluate positive bioassay data in INL claimants' files for radionuclide ratios
    2. **SRDB** – Evaluate documents with workers' bioassay data for radionuclide ratios
    3. **SRDB** – Evaluate documents with CAM/filters/smears data for radionuclide ratios

# SC&A's Current Progress

Preliminary results show:

- Some recorded data provide lower FAP intakes than would be assigned by using ORAUT-OTIB-0054
- Some recorded data provide lower actinide (Pu-238) intakes than would be derived by using ORAUT-TKBS-0007-5
- Some recorded data provide for greater actinide intakes (Pu-238 and/or Am-241) than would be derived by using ORAUT-TKBS-0007-5

# Areas to be Addressed by SC&A

- *SC&A is currently determining if the burnup in the fuel elements used by NIOSH is applicable/bounding to the situations at INL*
- *SC&A is currently investigating the use of one model and only three fuel elements to bound the intakes/doses*
- *SC&A needs to determine if records of analyses of dissolver contents are available; preferably, for a variety of INL reactor fuel elements*

## Areas to be Addressed by SC&A (cont'd)

- *Document research is still needed to evaluate NIOSH's recommended ratio value, especially for actinides*
- *Further investigations will be aided by the recent electronic bioassay database; even if this database is presently incomplete, paired FAP and actinide bioassays can provide relevant information*

SC&A estimates that we can deliver a report to the WG in October 2015 – well in advance of the November Board meeting

# Reactor Modeling

- Concerns: Frequently, air-sampling or urinalysis data on worker exposure to MFP/MAP associated with nuclear reactors or fuel are available only in the form of gross beta or gross gamma activity unattributed to specific radionuclides. ORAUT-OTIB-0054 provides guidance on assigning radionuclide-specific intakes using ratios to Cs-137 or Sr-90 indicator radionuclides.

The OTIB considers nine cases for four representative reactors with different specific power levels, irradiation times, and burnups.

- Are the many INL reactors and operating scenarios (some of which are “exotic”) adequately enveloped by the OTIB cases, so that the isotopic ratios are valid?
- Have all off-normal operating scenarios been identified, and are they adequately enveloped by the OTIB methodology?

# Reactor Modeling (cont'd)

- Recommendations: Investigations so far have been primarily for normal operations of the three major Test Reactor Area (TRA) reactors: Materials Test Reactor (MTR), Engineering Test Reactor (ETR), and the Advanced Test Reactor (ATR).
- SC&A should investigate the applicability of OTIB-0054 to the:
  - off-normal operating scenarios, including “special” materials irradiation runs and any incidents for the TRA reactors.
  - characteristics of normal and off-normal operating scenarios of other INL reactors, such as in Test Area North (TAN), which hosted very unusual reactor experiments, such as the Advanced Nuclear Propulsion (ANP) reactors, which were decidedly different in fuel composition and arrangement and operation than other types of reactors.

## Reactor Modeling (cont'd)

SC&A estimates that we can deliver a report on Reactor Modeling in October 2015, well in advance of the November 2015 Board meeting

# Burial Grounds

## Concerns

- Evidence exists that a “strict” contamination control program was not in place
- Site apparently lacked adequate smear counting capability for some length of time before early 1970s
- Radioactive waste was not specifically identified for most drums, boxes, and other containers in early years
- Offsite waste received from commercial, university, ERDA, and military sources in 1960–1963 inadequately identified
- AEC concerned over conflicted role of health physicists at the Burial Grounds, who were responsible for much of its operation, as well as radiation protection
- Internal investigations and appraisals bring into question “robustness” of HP program and “defense-in-depth” approach for radiological controls, as cited in the ER

# Burial Grounds (cont'd)

## Recommendations

- Conduct additional interviews with former Burial Grounds workers with experience during the time period in question (1952–1970); emphasis on radiological control program
- Conduct additional data capture with focus on the following:
  - Additional evidence of potential intakes to radwaste handlers
  - How contamination control was administered
  - Available routine and special air-sampling data
  - Robustness of health physics program: independence, resources, monitoring practices

# Burial Grounds (cont'd)

## Recommendations, Cont'd

- Evaluate dose assessment feasibility
  - Review external and internal dose electronic database when completed by NIOSH.
  - Review historic bioassay procedures and practices.
  - Can all Burial Grounds workers be identified?
  - Can all significant radioactive waste source terms be identified and addressed?

**Path Forward: Because the Burial Grounds investigations are in a preliminary stage and depend to a large extent on future worker interviews and data capture efforts, which require site hosting and coordination with NIOSH, SC&A is not in a position to provide a report delivery date at this time**

# Central Facilities Area (CFA)

- **Concerns**
  - CFA-handled radioactive materials from the entire INL site consisting of MFP, MAP, actinides, or a mixture of any or all
  - Difficult to bound MFP/MAP internal doses by assessing missed Sr-90 and/or Cs-137 intakes using ORAUT-OTIB-0054 and ORAUT-OTIB-0060
  - Because radioactive mix is not known, not practical to use Sr-90 and/or Cs-137 ratios in ORAUT-TKBS-0007-5 to determine actinide intakes

# Central Facilities Area (CFA) (cont'd)

## Facilities of Concern

- CF-640 Machine Shop – Radioactive material that the plant shops could not handle was worked on in the more fully equipped CFA Machine Shop. Usually this material was of a low radiation and contamination level.
- CF-665 Maintenance Shop – Worked on vehicles and equipment that were used to haul radioactive material. Vehicles were surveyed prior to shop maintenance work and sent to CPP for decontamination if needed.
- CF-669 Central Facilities Laundry – Washed coveralls and other protective clothing items used at INL. The old laundry facility (CF-699) was used from 1950 and was demolished in 1994.
- CF-674 Sewage Treatment Plant – Small amounts of radioactivity were processed through CF-674 to a drying pond. Most of the radioactivity was from the hot laundry, although small amounts could enter from CF-656 (Engineering Lab) and CF-690 (Analytical Lab).

# Central Facilities Area (CFA) (cont'd)

## Recommendations

- Evaluate the CFA radiological survey and air sampling results, both during operations and just prior to D&D, to determine actinide to Sr-90 and actinide to Cs-137 ratios.
- Compare these ratios to the values in Tables 5-22 and 5-23 of ORAUT-TKBS-0007-5.

**SC&A estimates that it can deliver a report on CFA in mid-to late-September 2015, well in advance of the November 2015 Board meeting**

# Chemical Processing Plant (Pre-1963)

- Currently proposed SEC Class 1963–1974
- Rationale for SEC Class: *“Increased potential for intake due to poor contamination control and inadequate personnel monitoring for exposures to transuranics separated from mixed fission products makes it unlikely that exposures to alpha emitters can adequately be reconstructed from January 1963 through December 1974.”*  
(NIOSH SEC ER)
- NIOSH has determined it is feasible to reconstruct all internal and external exposure at CPP prior to 1963

# Chemical Processing Plant (Pre-1963) (cont.'d)

Table 7-5: Feasibility Summary for CPP (1953-1974)

Exposure Source	Years																					
	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
MFP	F	F	F	F	F	F	F	F	F	F	F	F	F	F	C	C	C	C	C	C	C	C
Pu/Np	F	F	F	F	F	F	F	F	F	F	I	I	I	I	I	I	I	I	I	I	I	I
Uranium	F	F	F	F	F	F	F	F	F	F	I	I	I	I	I	I	I	I	I	I	I	I
Th/Transuranics	F	F	F	F	F	F	F	F	F	F	I	I	I	I	I	I	I	I	I	I	I	I
Other	F	F	F	F	F	F	F	F	F	F	F	F	F	F	C	C	C	C	C	C	C	C
Photon	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Neutron	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

F = Dose reconstructions are feasible.

C = Dose reconstructions are feasible but a mixed-fission-product co-worker model is needed.

I = Dose reconstructions are infeasible.

# Chemical Processing Plant (Pre-1963) (cont.'d)

## Concerns and Focus of SC&A Investigation

- Evaluate contamination incidents and control program prior to 1963
- Assess internal dosimetry program for CPP workers
  - Review of relevant claims for bioassay coverage in relation to established assignment to CPP
  - Adequacy of bioassay program to cover internal exposures to alpha emitters (e.g., uranium, plutonium)
- Characterize temporal changes in source term and exposure potential

# Chemical Processing Plant (Pre-1963) (cont.'d)

## Recommendations for Continued SC&A Investigative Activities

- Site Research Database Review
  - Documented contamination events and evaluation of contamination control program
  - Variations in radiological activities (source terms) at CPP
  - Hardcopy bioassay data specific to alpha emitters
- Claim File Review
  - Compile internal monitoring data on randomly sampled claimant population at CPP
  - Identify any incidents reported in dosimetry records or CATI reports
  - Evaluate the adequacy of internal monitoring for the purpose of dose reconstruction

# **Path Forward: Chemical Processing Plant (Pre-1963)**

**Because the Pre-1963 CPP investigations depend to a large extent on future worker interviews and data capture efforts, which require site hosting and coordination with NIOSH, SC&A is not in a position to provide a report delivery date at this time**

# Test Area North (TAN)

- Aircraft Nuclear Propulsion Program (ANP) (1952–1961)
- Initial Engine Test (IET)
  - Heat Transfer Reactor Experiments
- Technical Support Facility (TSF)
  - TAN 607 Hot Shop
  - LOFT (TAN 650)
  - Storage Pool
  - Storage Pads (TAN 790 and 791)
  - Radwaste Liquid Disposal System
  - Storage Building
  - Radiography Facility (TAN 607)
- Water Reactor Research Test Facility (WRRTF)
  - Low Power Test Facility (LPTF)
  - Shield Test Pool Facility (STPF)
- Specific Manufacturing Capability (SMC)

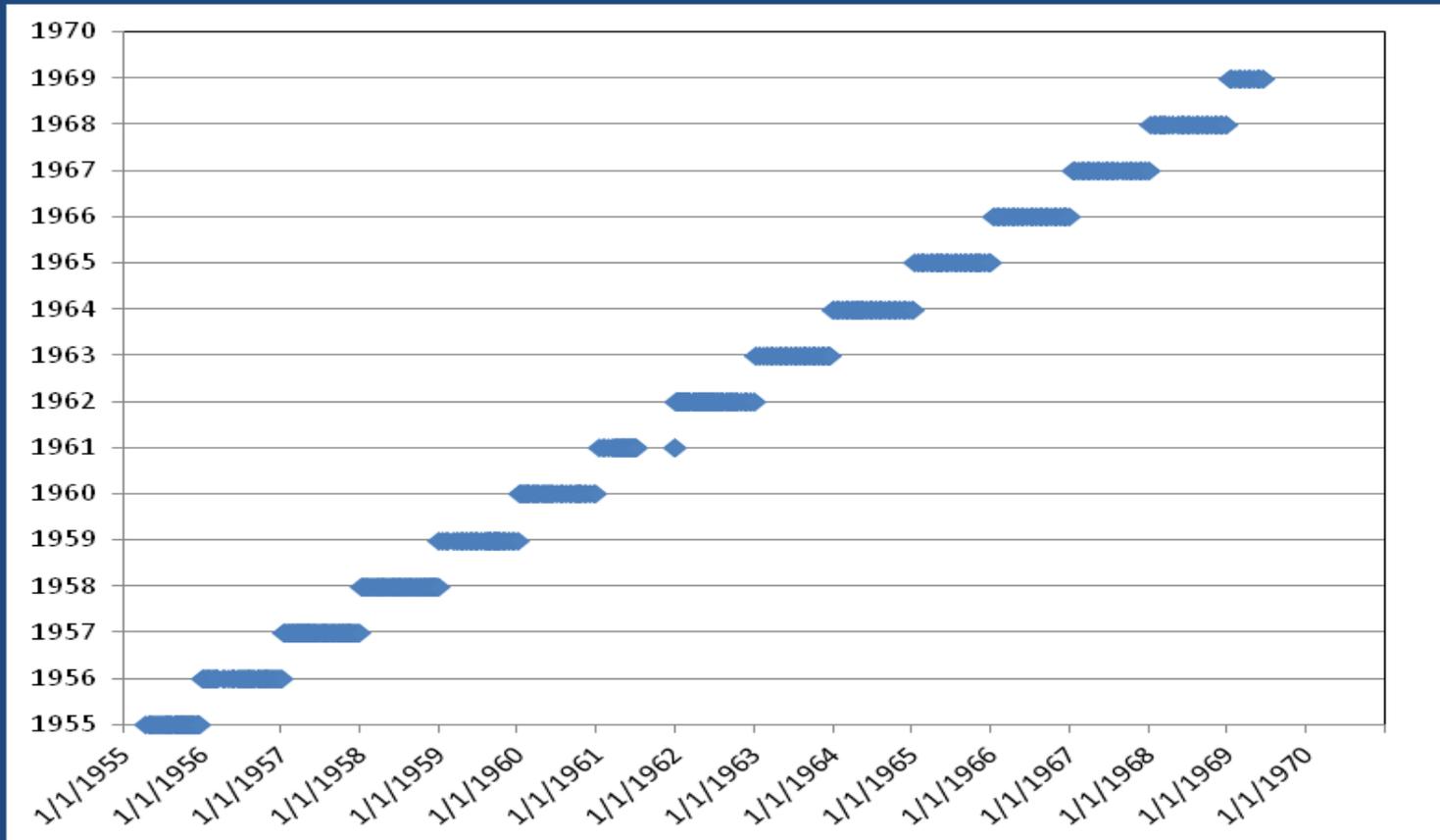
# TAN Scope of Analysis

- Focused on completeness of the external dosimetry data because:
  - Our review of the Evaluation Report and Site Profile revealed that, with the possible exception of neutron data, the quality of the external dosimetry data was very high
  - Review of the internal dosimetry data was being performed site-wide by others on our team and their findings would be applicable to TAN

# SRDB Documents Analyzed for TAN to Date

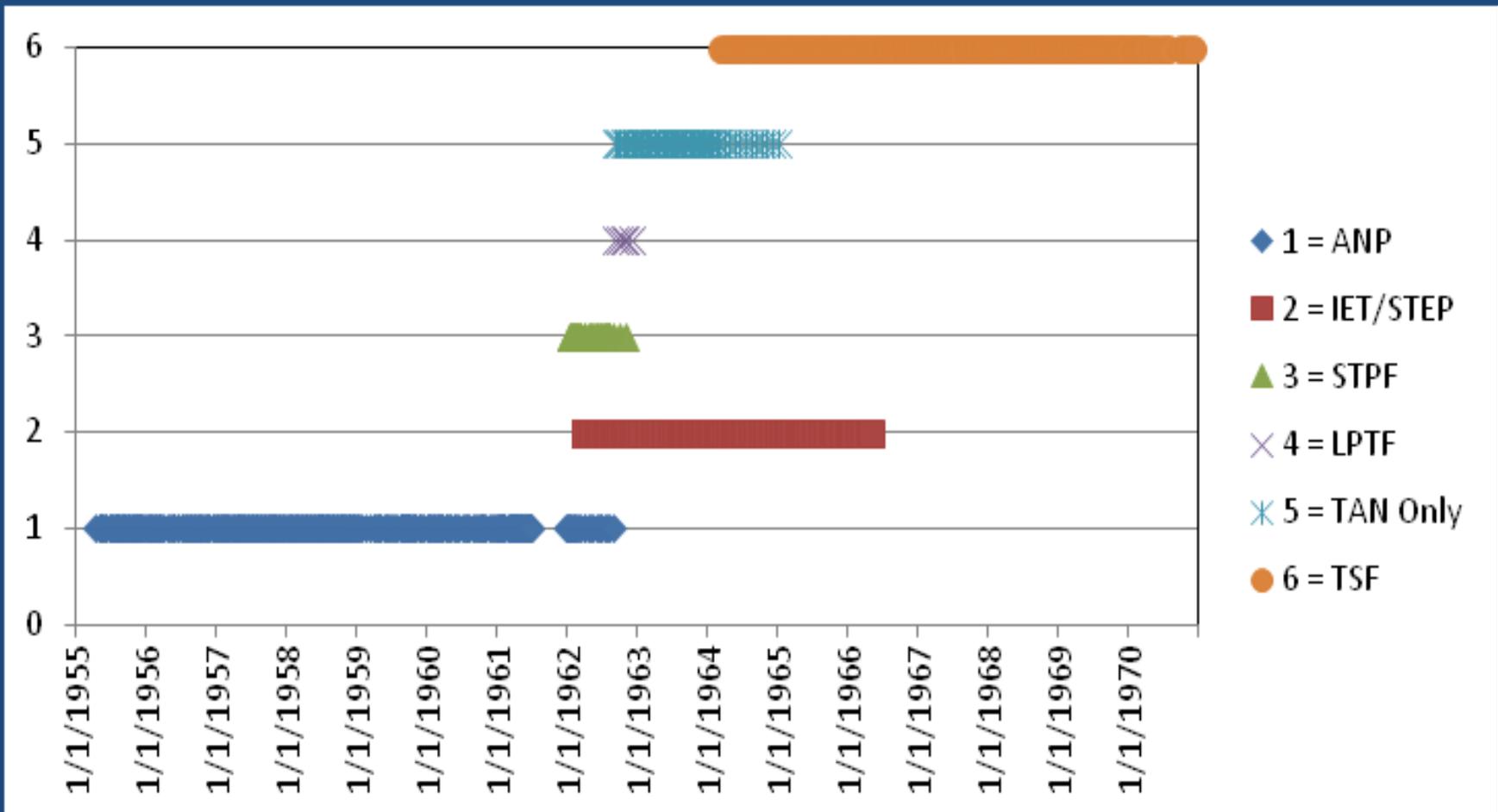
- Table 6, pp. 27–28 of Interim Report
  - 37 SRDB documents with dosimetry data analyzed
  - 12,177 pages in total
  - Areas mentioned within documents include ANP, TSF, IET/STEP, STPF, LPTF, and TAN in general
  - Records estimated to contain approximately 200,000 badges in total
  - Records contain approximately 7,000 neutron badges

# External Dosimetry – TAN as a Whole (Data Gaps)



Each point on this graph represents a date for which a dosimeter change-out was observed within the SRDB documents for a worker corresponding to any area of TAN. Numerous dosimeter change-out dates were seen for each year, with the exception of 1961, which had a small temporal gap in the available data.

# External Dosimetry – Sub-Areas of TAN



# Preliminary Observations and Recommendations for TAN

- Our preliminary review of the quality and completeness and the external dosimetry data at TAN is favorable.
- There appear to be some temporal and information gaps, particularly for dosimeters of sub-areas of TAN, and additional SRDB searches may help fill these gaps.
- Analysis of the completeness of neutron dosimetry data is underway.

# Preliminary Observations and Recommendations for TAN (cont'd)

- The external dosimetry records sometimes do not provide information on the sub-area where a worker experienced their exposures for a given change-out. In light of the highly varied activities that took place at the different sub-areas, the complete TAN dataset cannot be used to build a coworker model for unmonitored workers at a given facility within TAN. It is therefore recommended that the data available for each sub-area be compiled and plotted for use in building a coworker model for each sub-area, if it is determined that coworker models are needed due to the incompleteness of the external dosimetry database.

# **Preliminary Observations and Recommendations for TAN (cont'd)**

SC&A expects to deliver a report on TAN to the WG in September 2015, well in advance of the November 2015 Board meeting

## Summary – Path Forward

- SC&A expects to deliver reports to the WG on CFA and TAN sub-studies in September 2015
- SC&A expects to deliver reports on the cross-cutting issues of “Fission and Activation Product (FAP) Bioassay Indicator Radionuclides” and “Reactor Modeling” in October 2015
- Given the work that remains to be done on the Burial Grounds and CPP pre-1963, SC&A is not in a position to provide a delivery date at this time