Certified LabVIEW Developer Examination

Examinee: _____Date: _____

Administrator:_____Date: _____

Instructions:
If you did not receive this exam in a sealed envelope stamped "NI Certification," **DO NOT ACCEPT** this exam. Return it to the proctor immediately. You will be provided with a replacement exam.

- **Do not detach the binding staple of any section. If any part of the exam paper is missing or detached when returned to National Instruments, you will be deemed to have failed the exam.**
- This examination may not be taken from the examination area or reproduced in any way. You may not keep any portion of this exam after you have completed it.
- Do not ask the proctor for help. If any part of the exam is not clear, you may make appropriate assumptions and document them either on the exam paper or on the LabVIEW block diagram.
- A computer with a standard installation of LabVIEW is the only reference allowed for the examination. Externally developed code or third party tools are not allowed in the exam.
- The application must be specifically developed for the exam submission.
- The front panel and associated controls for the application are provided to you in a folder hierarchy on the USB memory stick. You **must** maintain the folder hierarchy and use these components to develop your application. Solutions that do not use the hierarchy or the given components are not graded.
- Do **not** rename the main VI or any of the provided controls. Solutions with renamed main VI or controls are not graded. You may use LabVIEW design patterns, templates, and examples available in the development environment as a guide/resource for the application development.
- **Submit your completed application on the provided USB memory stick.** Failure to provide the solution on the memory stick results in automatic failure.
- Total time allocated for the exam: 4 hours
- Exam passing grade: 70%

Grading:
The application development exam consists of a total of 40 points which are allocated as follows:
- Programming style **(15 points)**
- Functionality **(15 points)**
- Documentation **(10 points)**

IMPORTANT:
- **When you complete the exam, place the exam document and the USB memory stick containing the saved application, along with any deliverables, in the envelope provided.**
- **Please SEAL and give the sealed envelope to your proctor.**

Section I: General Requirements

The Certified LabVIEW Developer exam tests your ability to develop a LabVIEW application.

The application should do the following:

- Function as specified in Section II of this document
- Conform to LabVIEW coding style and documentation standards (found in LabVIEW documentation – *LabVIEW Development Guidelines*)
- Be created expressly for this exam using VIs and functions available in LabVIEW. Templates, examples, or code developed outside the bounds of this exam are not acceptable for use in the application
- Be hierarchical in nature. All major functions should be performed in subVIs
- Use a state machine that either uses a type-defined enumerated control, queue, or Event structure for state management
- Be easily scalable to add more states/features without manually updating the hierarchy
- Minimize the use of excessive structures, variables (locals/globals) and property nodes
- Respond to front panel controls (within 100 ms) without utilizing 100 % of CPU time
- Close all opened references and handles where used
- Be well-documented, and include the following:
    - Labels on appropriate wires within the main VI and subVIs
    - Descriptions for each algorithm
    - Documentation in **VI Properties»Documentation** for both main VI and subVIs
    - Tip strips and descriptions for front panel controls and indicators
    - Labels for constants

Application Development
Section I: General Requirements

The Certified LabVIEW Developer exam tests your ability to develop a LabVIEW application.

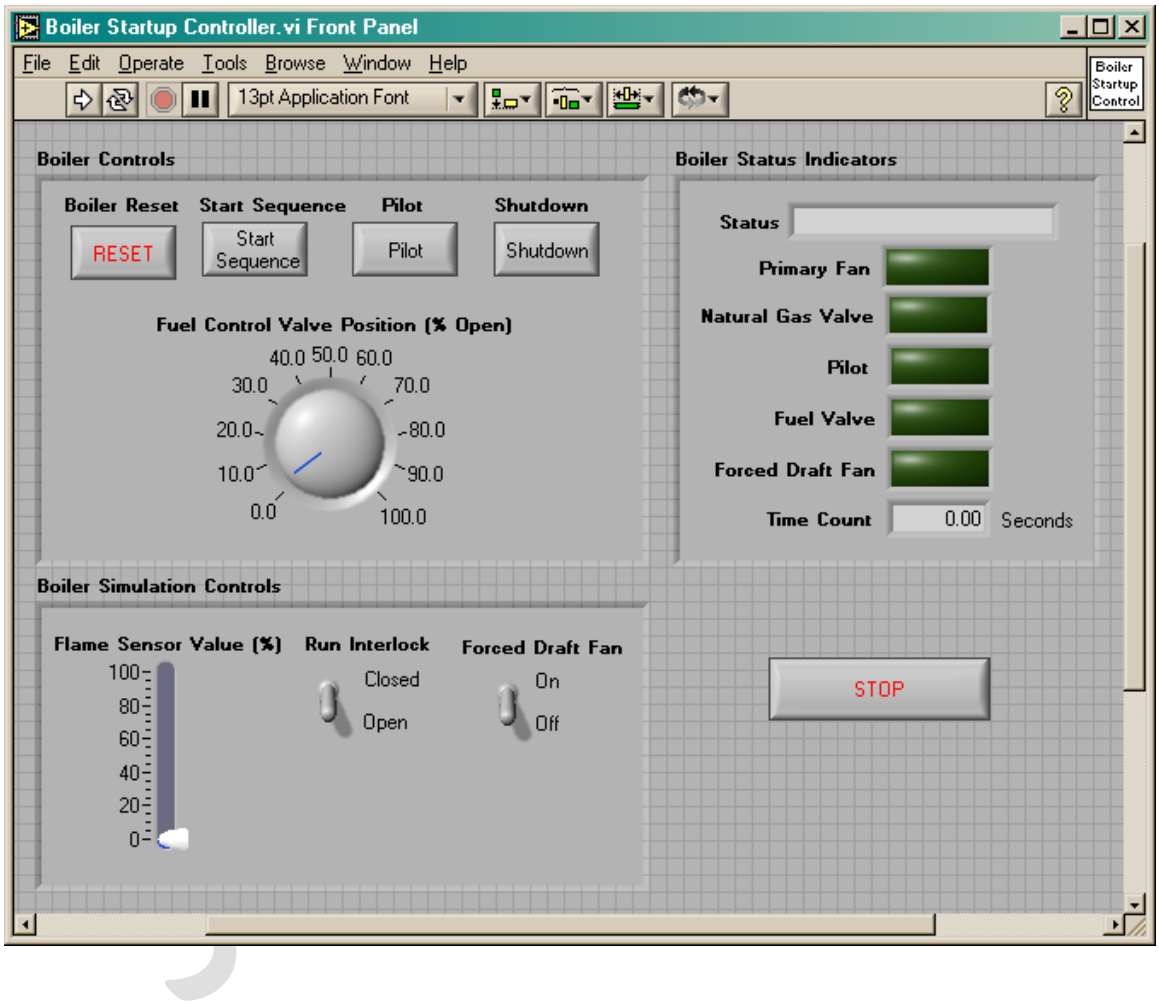
The application should:

- Function as specified in *Section II: Application Requirements* of this document.
- Conform to LabVIEW coding style and documentation standards found in LabVIEW documentation –Refer to the *Development Guidelines* section of the *LabVIEW Help.*.
- Be created expressly for this exam using VIs and functions available in LabVIEW. Templates, examples, or code developed outside the bounds of this exam are not acceptable for use in the application.
- Be hierarchical in nature. All major functions should be performed in subVIs.
- Use a state machine that either uses a type-defined enumerated control, queue, or Event structure for state management.
- Be easily scalable to add more states / features without having to manually update the hierarchy.
- Minimize the use of excessive structures, variables (locals / globals) and Property Nodes.
- Respond to front panel controls (within 100 ms) and not utilize 100% of CPU time.
- Close all opened references and handles where used.
- Be well documented and include the following:
    - Labels on appropriate wires within the main VI and subVIs
    - Descriptions for each algorithm
    - Documentation in **VI Properties » Documentation** for both main VI and subVIs
    - Tip strips and descriptions for front panel controls and indicators
    - Labels for constants

Application Development
Section II: Application Requirements
Boiler Controller

Objective

Design a boiler startup controller using LabVIEW. The front panel of the simulator resembling the following front panel is provided to you as a VI on the USB memory stick. **You must use the provided VI and controls to develop your application.**



General Operation

The boiler startup controller allows a user to start up and shut down a boiler. The user interacts with controls on the front panel to start up and shut down the boiler and simulate conditions in the system. Indicators on the front panel display the status and the current step in the startup and shutdown process. The controller also logs events as they occur during the process.

Sequence of Operation

Note: *See Event Log File Specification section later in the document for file format and update policies.*

Start (Application Run): When the application starts, the **Status** string should indicate **`Lockout`** and all indicator LEDs should be OFF. All controls should be initialized to the state shown on the previous front panel.

The following data should be logged to the event log file:
- Time string: Absolute date and time at event
- Event string: **`Boiler Initialized`**
- Event data string: **`0`**

Reset Lockout: Turn the **Run Interlock** switch to the closed position and click the **Boiler Reset** button. This action should change the **Status** string to indicate **`Ready`**.
Note: *The purpose of the* ***Run Interlock*** *switch is to simulate external condition(s) that need to be satisfied before beginning the start sequence.*

The following data should be logged to the event log file:
- Time string: Absolute date and time at event
- Event string: **`Boiler Ready`**
- Event data string: **`0`**

Pre-Purge: Click the **Start Sequence** button. This action starts the primary fan for the pre-purge cycle. This step should last for 10 seconds, during which:
- The **Primary Fan** LED should turn ON
- The **Time Count** indicator should count up to indicate elapsed time in seconds
- The **Status** string should indicate **`Pre-Purge`**

The following data should be logged to the event log file:
- Time string: Absolute date and time at event
- Event string: **`Start Pre-Purge`**
- Event data string: Pre-purge elapsed time

Pre-Purge (continued): Upon completion of this step, the following should occur:

- The **Status** string should indicate **`Pre-Purge Complete`**
- The **Primary Fan** LED should turn OFF
- The **Time Count** indicator should reset to `0`
- The **Pilot** button should blink to signal that it is safe to ignite the pilot

The following data should be logged to the event log file:

- Time string: Absolute date and time at event
- Event string: **`Pre-Purge Complete`**
- Event data string: Pre-purge elapsed time

Ignition (Ignite Pilot): Click the **Pilot** button. This action starts the flow of natural gas to provide the fuel and simultaneously creates the spark to ignite the pilot. This action should:

- Turn off the blinking of the **Pilot** button (initiated in previous step)
- Turn ON the **Natural Gas Valve** LED and **Pilot** LED
- Change the **Status** string to indicate **`Pilot On`**

Note: *The pilot should ignite only after the boiler completes the pre-purge step.*

The following data should be logged to the event log file:

- Time string: Absolute date and time at event
- Event string: **`Pilot ON`**
- Event data string: True

Prove the Pilot: This step verifies an adequate pilot flame for firing the boiler and is simulated by manually incrementing the **Flame Sensor Value** slider. When the **Flame Sensor Value** is greater than 30%, the **Status** string should indicate **`Boiler Ready`**.

The following data should be logged to the event log file:

- Time string: Absolute date and time at event
- Event string: **`Pilot Proved`**
- Event data string: Value of **Flame Sensor Value** slider

Start and Run:

Step 1: Turn ON the **Forced Draft Fan** switch. The **Forced Draft Fan** LED should turn ON.

The following data should be logged to the event log file:

- Time string: Absolute date and time at event
- Event string: **`Forced Draft Fan ON`**
- Event data string: True

Start and Run (continued):
Step 2: Move the **Fuel Control Valve Position** knob. The boiler should not start when the **Fuel Control Valve Position** is between 0% and 10%. The boiler should start only when the **Fuel Control Valve Position** is greater than 10%. At this time:

- The **Fuel Valve** indicator should turn ON
- The **Natural Gas Valve** LED and **Pilot** LED should turn OFF
- The **Status** string should indicate **`Boiler Running`**

The following data should be logged to the event log file:

- Time string: Absolute date and time at event
- Event string: **`Boiler Running`**
- Event data string: Value of Fuel Control Valve Position

The boiler should operate normally when the **Fuel Control Valve Position** is between 10% and 75%.

Shutdown and Purge: Any of the following conditions can shut down the boiler after the Start and Run step:

- Boiler Shutdown switch is clicked
- Fuel Control Valve Position is less than 10% or greater than 75%
- Run Interlock switch opens
- Forced Draft Fan switches OFF

The shutdown process initiates a purge cycle. The purge cycle should last for 10 seconds and begin by:

- Turning OFF the **Fuel Valve** indicator
- Turning ON the **Primary Fan** indicator
- Changing the **Status** to indicate **`Purge`**

The following data should be logged to the event log file:

- Time string: Absolute date and time at event
- Event string: **`Start Shutdown Purge`**
- Event data string: Purge elapsed time

Increment the **Time Count** indicator to indicate elapsed time in seconds. After the purge cycle is complete, the **Status** string should indicate **`Lockout`** and all indicator LEDs should turn OFF.

The following data should be logged to the event log file:

- Time string: Absolute date and time at event
- Event string: Shutdown Purge Complete
- Event data string: Purge elapsed time

Event Log File Specification

File Name: `Boiler Log.txt`
File Location: Relative – same location as the main VI
Format: Comma Separated Value (.csv)
File Header: Timestamp, Event, Event Data
Event Data string format: Absolute date and time string, Event string, Event data string
File Data: See *Sequence of Operation* section above
File Creation and Modification: If file does not exist, create new, write header and log event data. If file exists, append event data.