# Research into Cold Conditioning of IBCs
# Phase 2 – Pre-chilled Liquid


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# 1. Introduction

From the statistical analysis of the data collected during Phase 1 of this research, LOGSA was able to determine the time necessary to cold condition an IBC starting from ambient conditions. The results of the analysis showed that both IBC design types required 96 to 100 hours of conditioning to reach thermal equilibrium at -18 °C. The results also demonstrated that the initial expectation that the rigid IBC would take several hours longer to reach equilibrium did not hold true. As stated in the previous phase of research, the wording in the Code of Federal Regulations (49 CFR) is vague and lacks adequate instructions. This gives rise to a lack of consistency in methods and equipment used across testing labs, which creates concerns about the reliability of the results reached by each lab.

LOGSA's approach to addressing those concerns was to collect a larger set of data using a setup consisting of several thermocouples placed throughout the IBCs. The result was a more accurate representation of the actual time needed to reach thermal equilibrium between the IBC, its contents, and the conditioning environment. As part of the overall evaluation of the methods used by labs, it was necessary to determine how long an IBC filled with a pre-chilled solution would take to reach thermal equilibrium. The aim of both phases is to assist the DOT with clarifying or adding to the language of the 49 CFR so as to avoid further misinterpretations and reduce the variation in preparation and test methods. Motivation for this research stems from the desire to standardize test methods and eliminate possible differences in test results, with the ultimate goal being to increase transportation safety. This will be accomplished by improving the reliability and consistency of testing.

This paper will provide a clear and concise definition of the problem and a set of data to support the conclusions. Included, will be a background on the challenges experienced as a result of the vague language in the 49 CFR along with the technical information behind thermal transfer and the related material properties. An explanation and diagrams of the experimental setup and method will follow with a detailed analysis of the data and the statistical methods used. This research will prove valuable in PHMSA's efforts to enforce the regulations, while also helping to reduce costs associated with enforcement actions, and improve the efficiency of inspections and subsequent administrative processes.

# 2. Related Work

The research completed in this phase builds on the previous phase and all available testing literature. Evaluation of ASTM guides[1] from recent years was completed during Phase 1. The principles and methods covered in those guides were in part used to develop the research plan employed by LOGSA. As previously mentioned, the guides were developed by a committee group made up of LOGSA employees and representatives from other test labs and industry. In addition to those documents, LOGSA also incorporated a number of studies and test methods[2] which cover temperature effects on plastics.

[1] ASTM D7887, D4332, and D7790
[2] For example, ASTM D746

## 3. Regulatory Requirements

The regulatory requirements which cover the preparation of plastic IBCs prior to testing can be found in §178 of the 49 CFR. Specifically §178.810 states that rigid plastic IBCs and composite IBCs with plastic inner receptacles must be conditioned for testing by reducing the temperature of the packaging and its contents to -18 °C or lower. This section goes on to establish that test liquids must be kept in the liquid state, if necessary, by the addition of anti-freeze. The regulations allow for water/anti-freeze solutions with a minimum specific gravity of 0.95 for testing at -18 °C or lower. For the purposes of testing, those mixtures are considered equivalent to water. Considering the wording of the applicable sections of the regulations in their current form, it becomes clear that there is a lack of details for exactly how the required temperature should be reached and maintained. The language also fails to address differences in equipment and laboratory conditions.

## 4. System Model

As with the previous phase, an analysis of the data required a clear definition of the system and its variables along with the application of related engineering principles. The complexity of the system was reduced by breaking it down into smaller components and making certain assumptions based on the starting conditions and material properties. The reduction in complexity allows for easier analysis and a better understanding of how the system works. To remain consistent with Phase 1, the system was defined in the same way; an IBC and environmental chamber both considered to be isolated from the ambient conditions of the laboratory. For Phase 2, the only change to the system was the use of a pre-chilled liquid instead of the ambient temperature liquid. The liquid was chilled inside a separate IBC until thermal equilibrium was reached at -18 °C, at which point it was transferred into the test IBC.

### 4.1. Chamber and Surroundings

The chamber was defined as an isolated environment. This meant that the heat and mass transfer between the chamber and the laboratory environment was assumed to be zero. It was also assumed that the chamber provided a constant air flow rate, which was measured to be 20 mph at the vent opening.

### 4.2. Rigid and Composite IBC

The complexity of the transfer between the IBC and the chamber was simplified by treating the IBC's volume as constant without a transfer of mass between them. The change in internal energy of the system was assumed to be zero; without movement, friction between molecules can be neglected, including motion of the liquid during transfer to the test IBC. Heat transfer due to conduction between the IBC and the chamber is ignored because the bottles of the IBCs had no direct contact with the chamber floor. The shape of the IBCs was assumed to be ideal; a symmetric cube with uniform thickness and material. Although we recognize the importance of the surface geometry and overall design of the IBCs, air was treated as an ideal gas with a simplified heat transfer coefficient. Both IBCs (empty) started at ambient laboratory conditions: 23 °C and 50 % RH at a local altitude of approximately 1568 ft.

## 4.3. Test Lading

The lading is treated as a uniform mixture of water and Propylene Glycol (by volume) with no impurities. The volume of liquid is 275 gallons and is capable of reaching a temperature of approximately -30 °C without the formation of slush. The mixture was pre-chilled to -18 °C inside of a duplicate composite IBC. Once the mixture reached thermal equilibrium, it was transferred to the test IBC using pumps.

## 4.4. General Thermodynamics

For this phase of research, we applied the same thermodynamic principles that were used in Phase 1. The walls of the IBC were initially at equilibrium with the conditions in the laboratory (23 °C). This meant that once the IBC was filled with the liquid and placed inside the cold atmosphere of the chamber, that the plastic was warmer than its surroundings. As a result, the direction of heat transfer (as depicted in Figure 1 below) differed from the previous phase; heat moved from the plastic walls of the IBC out into the liquid mixture and the air circulating around the chamber.

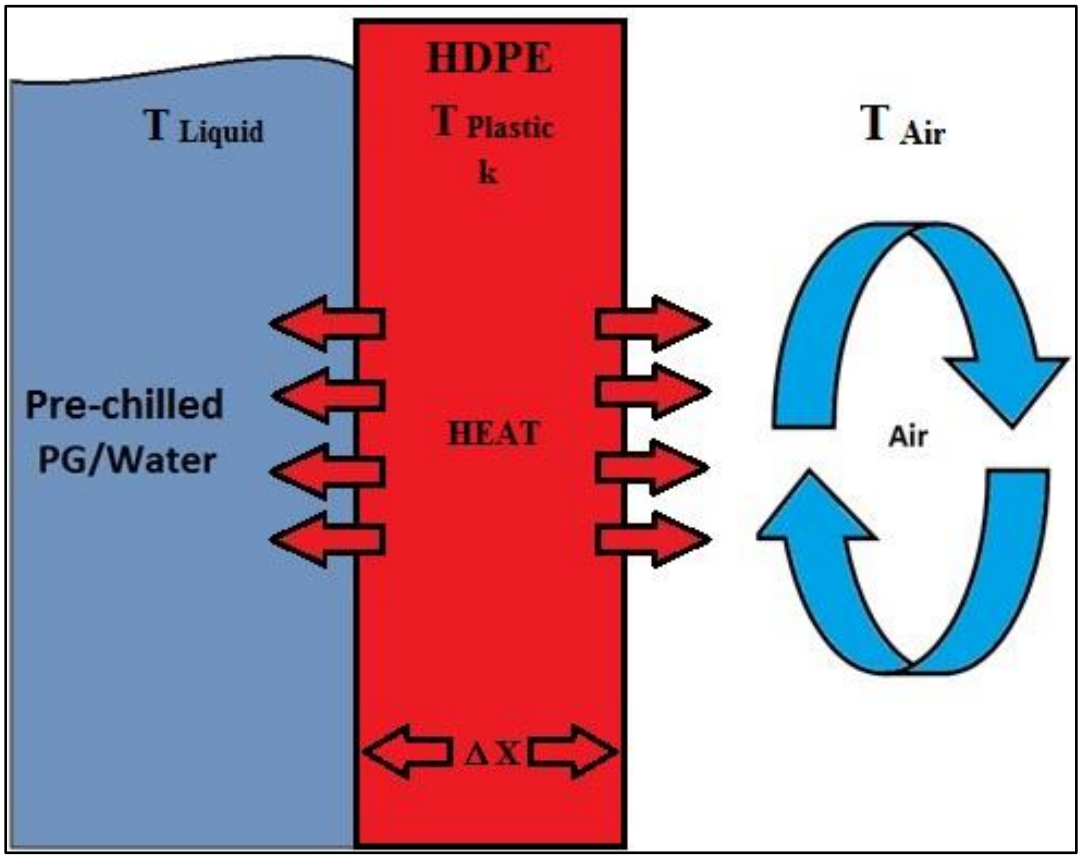


**Figure 1. Direction of heat transfer**

The most important factor which influences the system is the mode(s) of heat transfer. As stated in the previous phase, radiation and convection were identified as the primary modes of heat transfer in this system. The conduction experienced by the system is negated because of the limited direct physical contact between the IBC bottle and the chamber floor. The transfer due to radiation originates from the heat stored within the plastic walls of the IBCs. Once placed in the chamber, the heat stored in the plastic radiates in two directions; into the pre-chilled liquid and out into the chamber environment. The transfer of heat from the plastic into the chamber is also accomplished thru the forced convection created by the chamber's circulation fans.

The second most important factor is the materials from which the IBCs are constructed. In this situation the materials are identical to those used in the previous round of conditioning. The physical properties and the manner in which those materials were handled and used to construct the IBC play an integral part in the rate of heat transfer. The rate varies due to different heat transfer coefficients. The higher the coefficient, the more rapidly heat is transferred thru that material. Going further, the rate of heat transfer is directly proportional to the surface area through which the heat is being conducted; larger areas transfer heat at a higher rate. The material thickness also influences the heat transfer, with the relationship being that the rate is inversely proportional to the thickness. This means that the heat is transferred faster thru thinner materials.

Thermal Conductivity is the property of the material to diffuse or conduct heat. Materials with high values are referred to as heat sinks because they quickly diffuse heat and materials with low values are considered insulators because they slowly diffuse heat. Thermal Conductivity in relation to the amount of material is also a common estimate of the heat transfer coefficient. The values for the materials in this system are listed in Table 1.

| **Material/Substance** | **Thermal Conductivity** | |
|---|---|---|
| Propylene Glycol | 0.147 | W/m K |
| 50/50 Mix (@ +23 °C) | 0.396 | W/m K |
| 50/50 Mix (@ -18 °C) | 0.364 | W/m K |
| Air (*forced convection)* | 46.2092 | W/m K |
| High Density Polyethylene | 0.52 | W/m K |

**Table 1. Thermal Conductivity of materials**

Thermal equilibrium was again defined to be the point at which the IBC and its contents reached the same temperature (-18 °C) as the inside of the chamber. In order to accomplish this, the chamber was set to a temperature which took into account equipment and the packaging being conditioned (-22 °C). It is important to note, that the rate at which the temperature changes is proportional to the rate at which heat is being transferred. In other words, the transfer rate slows as the temperatures get closer to equilibrium. As a result, the IBC and its contents transferred heat and reached equilibrium more slowly as the difference in temperature decreased.

In regards to material properties it is important to note that although there are general properties for all materials, the properties of a specific sample also depend heavily on its history. This means that the behavior of HDPE depends not only on the resin, but how it was processed and handled afterwards (i.e. storage environment). Handling includes events such as any previous heat treatments, mechanical manipulation, annealing processes, exposure to UV light, and additives. Also taken into account are the melt and glass transition temperature of the plastic, which are two fundamental properties of any polymer. For the purposes of cold conditioning, we were primarily interested in the glass transition temperature, which is the point below which the polymer becomes hard and relatively brittle. Variation in the glass transition is based on several factors, including but not limited to; the specific molecular structure of the base polymer, the molecular weight, the molecular weight distribution, and additives. The glass transition temperature of HDPE was identified to be approximately -100 °C; however it can show signs of being brittle beginning at – 80 °C.

## 5. Procedure

As was mentioned in the first phase of research, temperature monitoring is typically accomplished using only one thermocouple. In some cases the temperature of the package is not measured directly, but instead is assumed to be at the required value after setting the chamber and waiting a prescribed amount of time. However, in order to accurately and reliably determine the time needed to reach the required temperature, several thermocouples in multiple locations are necessary over the entire conditioning period. The study was conducted on the two most common IBC design types seen by LOGSA in the past five years; a 275 gallon composite IBC with steel cage (Figure 2) and a 275 gallon rigid plastic IBC (Figure 3).

**Figure 2. Composite IBC with metal cage**


**Figure 3. Rigid plastic IBC**

Prior to the period of conditioning, an IBC was filled with a pre-chilled Propylene Glycol and water mixture. The liquid was chilled inside an extra composite IBC of the same design used in this study. Once the required temperature (-18 °C) was reached, the mixture was then transferred to the test IBCs. For both IBC designs, the starting temperature was ambient laboratory (23 °C). In the case of the composite IBC, the time it took to transfer the chilled

mixture was approximately 25-30 minutes. For the rigid IBC, the time it took to transfer the chilled mixture was approximately 15-20 minutes. In order to reduce the time needed to transfer the pre-chilled liquid, a second pump was utilized when filling the rigid IBC. The container filled with the pre-chilled liquid was also kept inside the chamber to maintain temperature.

The configuration used to collect the temperature data was the same for both IBC design types. It consisted of twenty-four thermocouples; fourteen were submersed inside the IBC on a frame, eight were mounted centrally on the inside and outside surfaces[3] of the side walls, one was mounted on the exterior bottom, and one was mounted several inches above the top of the IBC[4]. The thermocouples were attached to an electronic data acquisition system where the temperature readings were collected over the period of conditioning[5]. Due to decomposition of the wooden components as a result of exposure to the liquid mixture, the arms of the support frame used in Phase 1 were replaced with metal rods. Diagrams of the frame and the specific locations of the thermocouples are shown in Figure 4 below and Appendix B, Figures B1, B2, and Table B1. Once the thermocouples were in place, the IBC was placed inside the empty chamber, as shown in Figure 5.

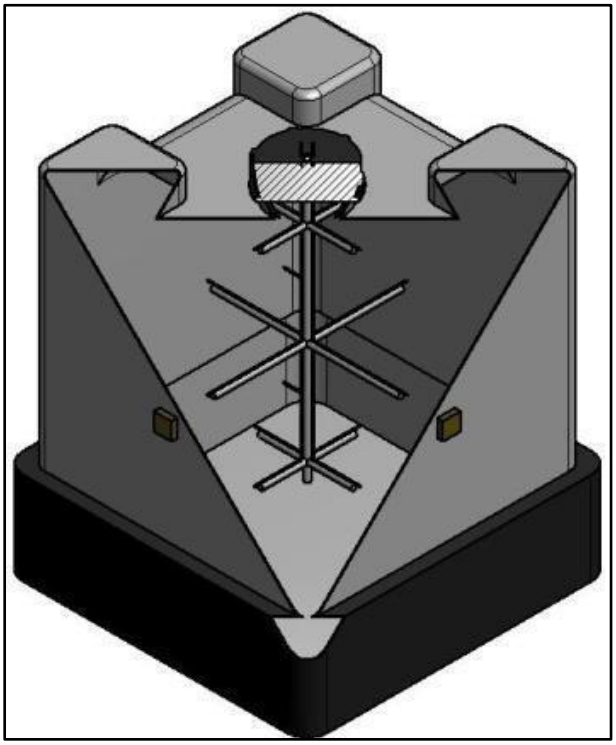

**Figure 4. Model of frame submerged in IBC**

[3] All surface mounted thermocouples were those purchased from Omega Engineering, Inc.
[4] An additional thermocouple was mounted above the composite IBC for comparison purposes
[5] The system and thermocouples were calibrated prior to the start of conditioning


**Figure 5. Placement of IBC within chamber**

The thermocouples were wired to the data acquisition system which consisted of a 1-MHz, 16-bit USB data acquisition module manufactured by Omega Engineering Inc. and a computer with the accompanying software. Once the thermocouples were connected and the data module and software were activated, the chamber was closed and the refrigeration was turned on. The chamber's cooling system pulls the heat from the atmosphere and circulates the cooler air back around the IBC. The thermocouple which monitors the chamber temperature, shown in Figure 6, is located near the opening for the circulation fans at the top of the chamber's rear. It is this thermocouple that is used by the chamber controller to maintain the desired setting. The composite IBC was the first to be conditioned, with the chamber being set to -22 °C based on our experiences from Phase 1.

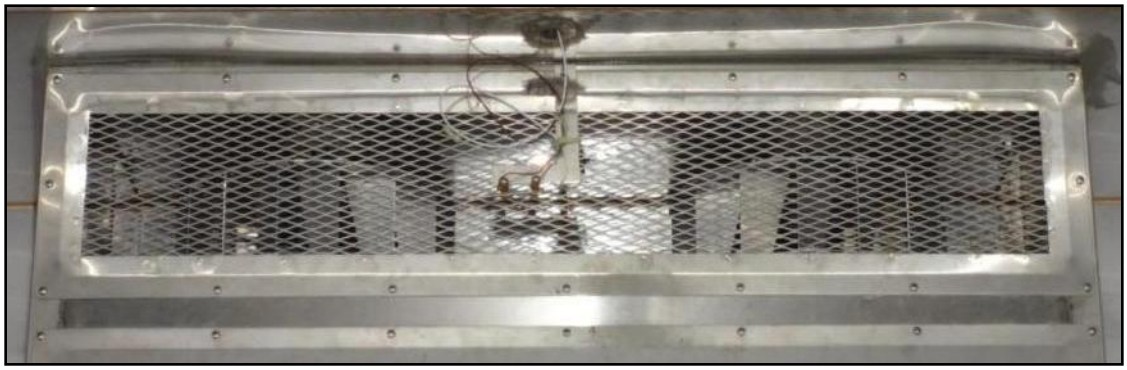

**Figure 6. Location of chamber's thermocouple**

The same sampling time used in Phase 1 was also used in this phase. Once the data was collected, it was transferred to another PC and imported into Excel as a text file. The first part of the analysis was to check and see if the general trend of the data met the expectations that were

based on observations from earlier work. The next step was to perform a reduction on the total number of data points in order to decrease the complexity, but at the same time maintain the trend. The reduction was accomplished by using only the data points taken every sixty minutes, or once per hour. The resulting data set was then broken down into twenty-four hour periods.

## 6. Analysis

There are several factors which influence heat transfer; the size of the package, the material(s) of construction, the equipment used, the test lading, and the overall design of the package, to name a few. The system in question is complex because of the large number of variables and their uncertainty over time. As a result, a direct calculation of the heat transfer rate would be difficult. The ideal method for demonstrating and understanding the behavior of the system was to collect the temperature data experimentally and then graph the response of the system. This method allows the data to be examined in smaller time intervals to more accurately determine the time at which thermal equilibrium is reached. The sampling time of one reading every thirty minutes was chosen to provide two temperature readings per hour and coincide with the sampling rate and reduction techniques of the previous phase. Those techniques allowed for easier management and statistical analysis of the data and had no effect on the overall trend that was observed.

While examining the data, it was noted that some of the thermocouples in the same locations demonstrated different temperatures. This was determined to be the result of the difference in sensitivity for the two types of thermocouples and had no negative effect on the results. This difference in sensitivity was noted in both phases of research and resulted in a number of outlying data points which had to be normalized. Other examples of outlying data would be those points which were the result of chamber power and/or defrost cycles. The graphs show that these points occurred at regular intervals. It was found that the period of time in which they occurred was approximately every 24 hours. Although they were a regular occurrence, they had a negligible effect on the overall data trend.

The statistical results were plotted on three dimensional contour graphs and the raw data was plotted on Temperature versus Time graphs. The data for the two IBC designs was noted to have the same general shape. This means that the overall trend in cooling was similar for both IBC designs. One of the more apparent observations was that the thermocouples placed on the outer faces of the IBCs were several degrees below the thermocouples located on the inner walls and the tiered fixture. This observation was expected, as the air moving around the outside walls of the IBCs produces a more rapid cooling effect through forced conduction, whereas the liquid inside the containers provides a certain degree of insulation, causing the temperature to change more slowly. In short, the variation in temperature readings was attributed to the thermal conductivity of the liquid versus the air.

Another observation made during conditioning was that the thermocouples located in Tier 1 of the fixture cooled the fastest out of all the thermocouples for both designs. Upon further examination, it was determined that this was due to the increased air flow and turbulence caused by the holes drilled in the IBC cap to insert the thermocouple wires. Additionally, from the 3-D contour graph, it can be seen that the temperature readings for Tier 1 were over a larger range

and changed at a faster rate. The holes were drilled in the cap to allow for easier closing without twisting the thermocouple wires.

For the composite IBC, it was noted that the inner and outer thermocouples mounted on Face 2 had a faster cooling rate. This may be due to the direction of air flow around that face. It is also hypothesized that the cage bars of the IBC may have caused additional turbulence. An examination of the 3-D contour graphs showed higher variance in the temperatures. This was also attributed to the increased turbulence experienced over the surface of the composite IBC. By comparison, the surface of the rigid IBC was smoother and therefore had less turbulence. In the case of the rigid IBC, the outer walls of Face 3 and Face 4 cooled at a faster rate. It was interesting to note that when a regression line was applied to the average scatter plot, that the temperature of the chamber appeared to have increased slightly overall. This may be due to the heat exchange over time.

## 7. Conclusions

Building on the work completed in the previous phase of research, LOGSA was able to establish a baseline for cold temperature conditioning starting with IBCs filled with a pre-chilled liquid. From the data collected and the subsequent statistical analysis, LOGSA has reached the conclusion that the total time needed to condition IBCs filled with a pre-chilled mixture is in excess of 24 hours.

The total time needed to reach cold conditions was derived from the graphs which plotted the temperature readings versus time (Figures C1 and C7 in Appendix C). Based on our analysis of the graphs, the rigid IBC took approximately 45 hours and the composite took approximately 61 hours to reach thermal equilibrium. As mentioned in the procedure above, there was a difference in the time taken to transfer the pre-chilled liquid between both IBCs. This difference in turn resulted in a variance in starting temperature of approximately 2° C. This means that the rigid IBC started at temperatures that were 2 °C lower than the composite IBC. Regardless of the difference in the time needed to transfer the liquid, it is in LOGSA's opinion that the period of time was negligible and did not influence the fact that each IBC took longer than 24 hours to reach the required temperature. Taking the longest period of transfer time into account (about 25-30 minutes), it was determined that it was not significant enough to lengthen the conditioning period by some 21 hours, and extend the total time in excess of the goal of 24 hours.

The difference in time between the 45 (rigid) and 61 (composite) hours can be explained by a number of factors. First, with a pre-chilled solution, the temperature difference between the IBCs and their surroundings is smaller. As a result, the rate of thermal transfer is slower because the rate of heat transfer is dependent on the magnitude of the difference in temperature. Taking into consideration that the rigid IBC started conditioning at temperatures which were 2 °C lower than the composite IBC, it stands to reason that the composite IBC would take longer to reach equilibrium. Second, with the replacement of the wooden rods of the thermocouple fixture with metal rods, the dynamic exchange of heat within the IBC was changed. Metal dissipates heat more efficiently than wood. Considering that, plus the fact that the thermocouples in Tier 1 cooled noticeably faster, the overall rate of heat transfer would have been higher (faster) than the composite IBC. Finally, although the IBCs both have a capacity of 275 gallons and have

receptacles made of high density polyethylene, the designs are not the same. The materials and method of construction for the IBCs are different. The metal bars of the composite IBC conduct heat differently than the plastic walls of the rigid IBC. The rigid IBC in turn has a much thicker sidewall than the composite.

As anticipated, the interior submerged and surface thermocouples of both IBCs took longer to reach equilibrium than the exterior thermocouples. The trend for the thermocouple located on the outside surface of Face 3 also matches the observations made during a previous study for cold conditioning of non-bulk packages; when on an elevated platform, or one with openings on the bottom, the package bottom cools faster due to the increased air flow. As was stated in the previous phase, the inner surface thermocouples are more indicative of the heat transfer process due to their location on the boundary of the plastic and the test lading and because the outside thermocouples are exposed to other variables, such as flowing air.

The varying color grade on the three dimensional contour graphs is defined as follows; green areas show slower heat transfer and blue area show faster heat transfer. The graphs also affirm two of the principles mentioned earlier; initially heat is being transferred at a higher rate, which is reflected by the steeper slopes near the beginning of the graph and the rate of change slows as the temperature differences between the thermocouples and the chamber setting decrease. The use of detailed temperature data allows us to present a more accurate portrayal of the IBCs during conditioning. It demonstrates how the temperature of the IBC and its contents changes over time and highlights the importance of multiple thermocouples to monitor the process. From the data collected, it is clear that a period of 24 hours is not sufficient to cold condition 275 gallon rigid plastic and composite IBCs to the required -18 °C even if they are filled with a pre-chilled liquid. However, using a pre-chilled liquid does reduce the time to below 72 hours.

Once again, it needs to be stated that this research does not address the internal temperature changes that take place within the plastic during conditioning. To measure that, it would be necessary to implant thermocouples directly into the plastic in order to truly measure the temperature within it. Unfortunately, that is beyond the scope of this project.

## 8. Next Step

This phase of research focused on developing a temperature profile for cold conditioning of IBCs using a pre-chilled liquid mixture. LOGSA will continue to collect data by following this latest round of conditioning research with drop tests of each IBC design type. The tests will compare the 24 hour and 72 hour conditioning periods and demonstrate the influence of the conditioning method on test results. LOGSA will also conduct a series of tests to determine the brittleness temperature of the plastic (using ASTM D746), with the goal being to aid PHMSA in evaluating the current temperature requirement and the language of the regulations and to provide additional physical evidence of the difference in test results between the two methods.

In order to accurately model the structural behavior of a material, it is important to know the shape of the stress-strain curve at the application temperature. Therefore, it may also be beneficial to perform compression and tension tests on samples of the HDPE at various

temperatures using a compression/tension tester. The results could then be compared to existing stress-strain curves as a means of examining the relationship between stress and strain as a function of changes in temperature. This is important, because although HDPE is a polymer which becomes stiffer as temperature drops, this trend is not necessarily linear with continuing temperature drop. All semi-crystalline plastics have temperature dependent behavior. Due to the lack of a predictable and repeatable structure in the material, changes in temperature always influence the mechanical properties of these materials.

It is important to note that in terms of failure, a rapidly applied load at room temperature can have exactly the same effect as a much lighter load at low temperatures. Therefore it can be said that brittleness in plastics is as much a function of time as it is of temperature. Assessing performance of plastics in low temperatures is complex and depends on a number of factors; rate of loading, the magnitude of the load, nominal surface stress, as well as others. Polymers are brittle at low temperatures and have low impact strengths, with a brittle to ductile transition over a narrow range of temperatures. The information from such comparisons could then be used to define the onset of the glassy phase for the HDPE used in the manufacture of the IBCs. Establishing the brittleness temperature is vital if a full understanding of IBC performance is desired.

# 9. Appendix A – Equipment Specifications

**Surface Mounted Thermocouples:**

Description: Precision fine wire thermocouples
Manufacturer: Omega Engineering, Inc.
Part Number: SA1-T-120
Specifications: Type-T thermocouple (Copper-Constantan), 30 AWG (PFA coated)
Temperature Range: -60 °C to 175 °C
Dimensions: 25 (L) x 19 (W) x 0.3 mm
Laminates: High temperature polymer and fiberglass reinforced polymer layers
Adhesive Pad: Silicon, pressure sensitive adhesive, polymide film

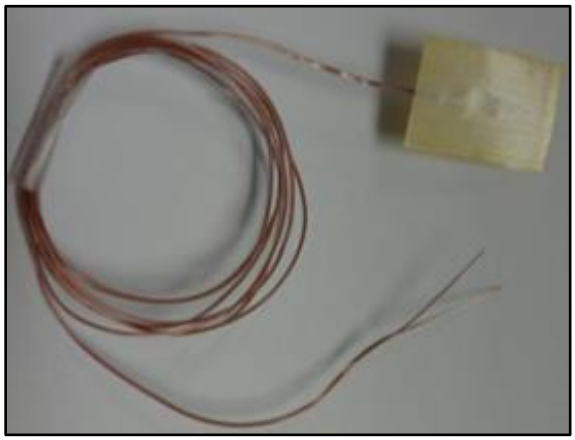

**Figure A1. Omega surface mount thermocouple**

**LOGSA Fabricated Thermocouples:**

Description: Wire thermocouples with soldered thermocouple junction
Manufacturer: LOGSA
Part Number: N/A
Specifications: Type-T thermocouple (Copper-Constantan)
Temperature: -270 °C to 400 °C
Dimensions: Various lengths based on location on IBC.

**Figure A2. Thermocouple fabricated by LOGSA**

Both thermocouples made use of an approved extension grade wire for connection to the data acquisition system.

**Data Acquisition Module:**

Description: 1 MHz, 16 bit multifunction USB module with synchronous input

Specifications: 8 differential / 16 single-ended analog channels (expandable up to 64 single-ended and 32 differential channels)

Inputs: Thermocouple or Voltage

Software: DaqView

Notes:

- Expansion module was used to increase number of channels
- User calibrated before testing
- Equipped with auto cold junction compensation

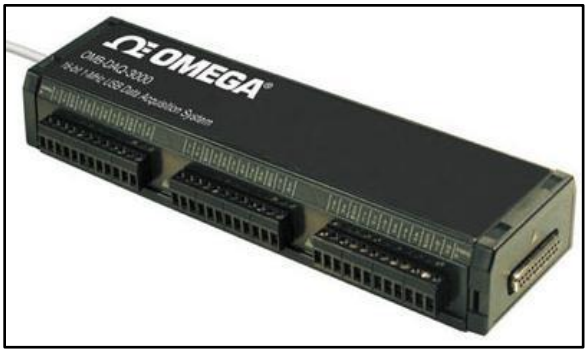


**Figure A3. Omega data acquisition module**


**Figure A4. Omega expansion module**

**Data Acquisition Software:**

Description: Real Time Data Acquisition System

Specifications: DAQview, Version 9.1.35

**Environmental Chamber**

Description: 12′ x 10′ environmental chamber

Temperature Range: -80 °F / -62 °C

Air Flow: 20 mph (measured at ventilation opening)

## 10. Appendix B – Supporting Figures and Diagrams

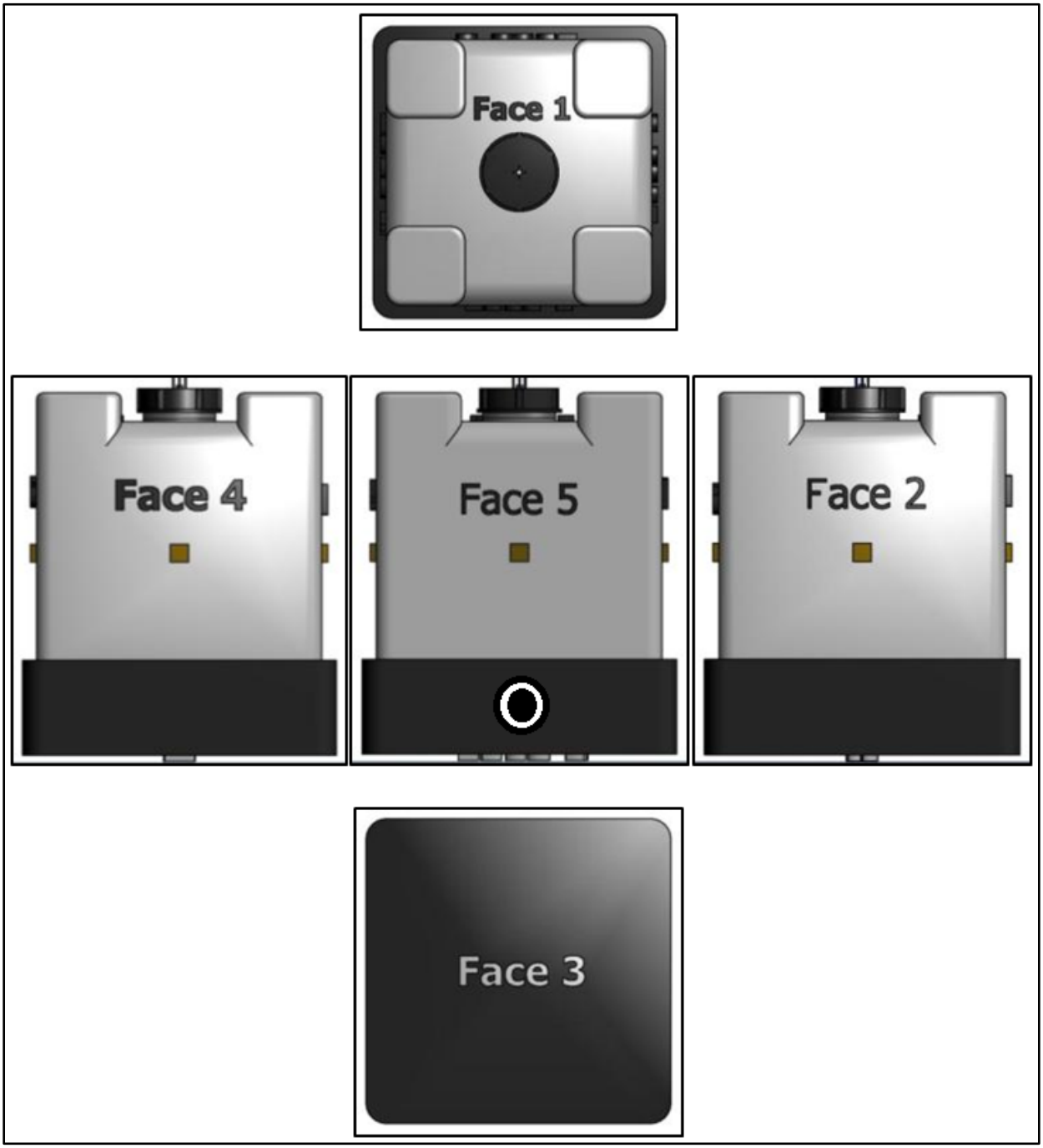


**Figure B1. Designation of IBC faces**

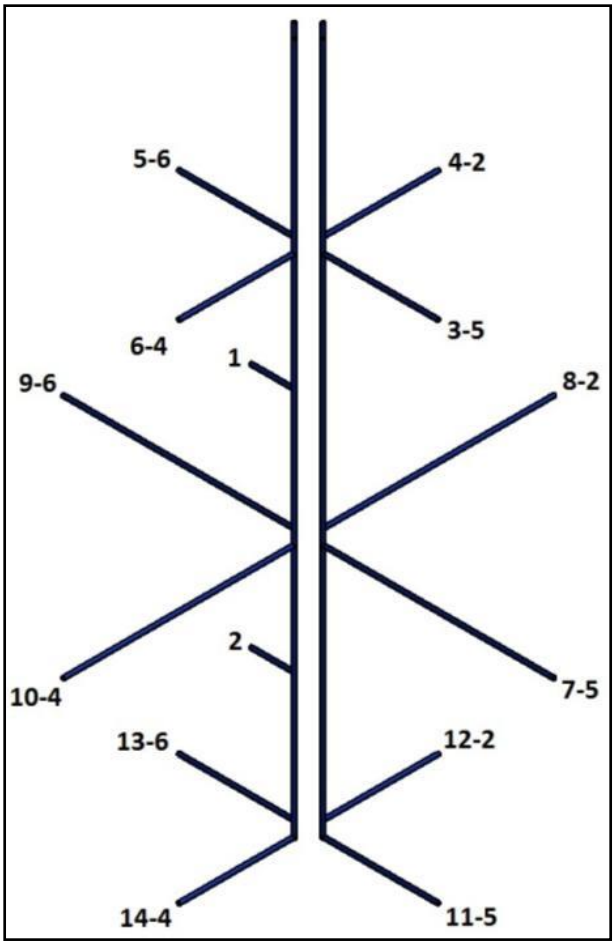


**Figure B2. Thermocouple position labels**

| Thermocouple[6] | Location[7,8] |
|---|---|
| 1 | Between tier 1 and 2 of frame |
| 2 | Between tier 2 and 3 of frame |
| 3-5 | Tier 1 of frame, facing inside of Side 5 |
| 4-2 | Tier 1 of frame, facing inside of Side 2 |
| 5-6 | Tier 1 of frame, facing inside of Side 6 |
| 6-4 | Tier 1 of frame, facing inside of Side 4 |
| 7-5 | Tier 2 of frame, facing inside of Side 5 |
| 8-2 | Tier 2 of frame, facing inside of Side 2 |
| 9-6 | Tier 2 of frame, facing inside of Side 6 |
| 10-4 | Tier 2 of frame, facing inside of Side 4 |
| 11-5 | Tier 3 of frame, facing inside of Side 5 |
| 12-2 | Tier 3 of frame, facing inside of Side 2 |
| 13-6 | Tier 3 of frame, facing inside of Side 6 |
| 14-4 | Tier 3 of frame, facing inside of Side 4 |

**Table B1. Description of thermocouple locations**

[6] All thermocouples placed on the frame were those fabricated by LOGSA
[7] Face 6 is the side opposite to Face 5
[8] Thermocouples were affixed to Faces 2, 4, 3, and 5; thermocouple for Face 1 was placed on a tripod

## 11. Appendix C – Graphs

Graphs C1 through C12 are plots of the temperature readings from each thermocouple over the course of cold conditioning.

### 11.1. Temperature vs. Time - Rigid IBC (All Thermocouples)

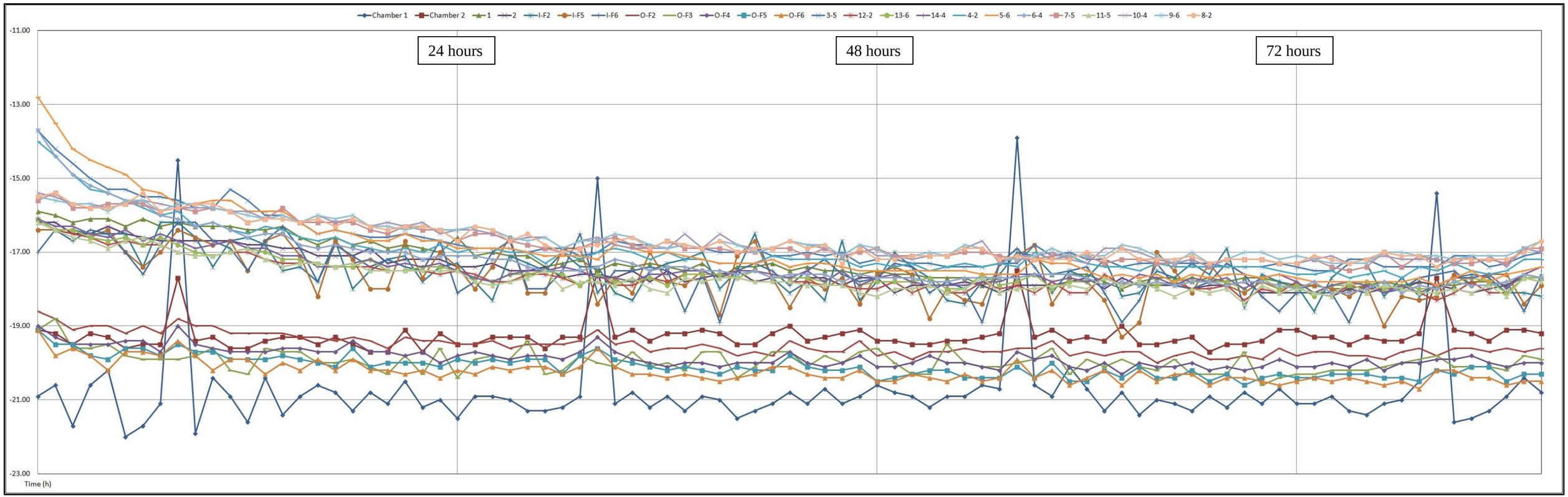


**Figure C1. Combined graph of temperature vs. time for rigid IBC**

## 11.2. Temperature vs. Time – Rigid IBC (Tier 1)

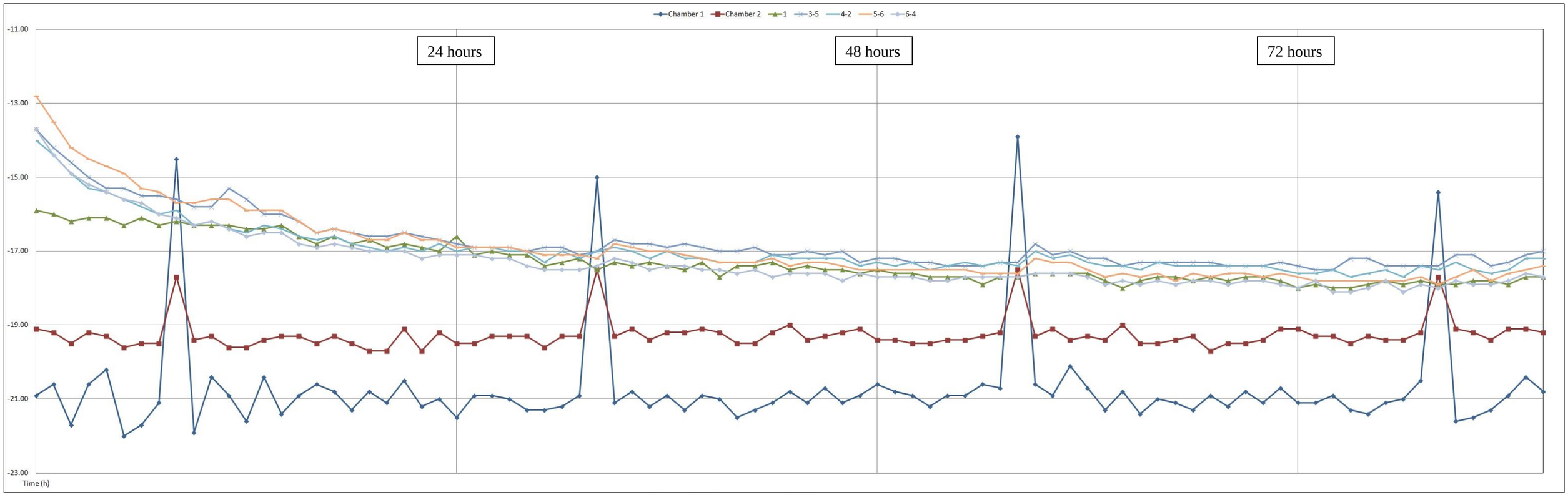


**Figure C2. Graph of rigid IBC Tier 1 thermocouples**

## 11.3. Temperature vs. Time – Rigid IBC (Tier 2)

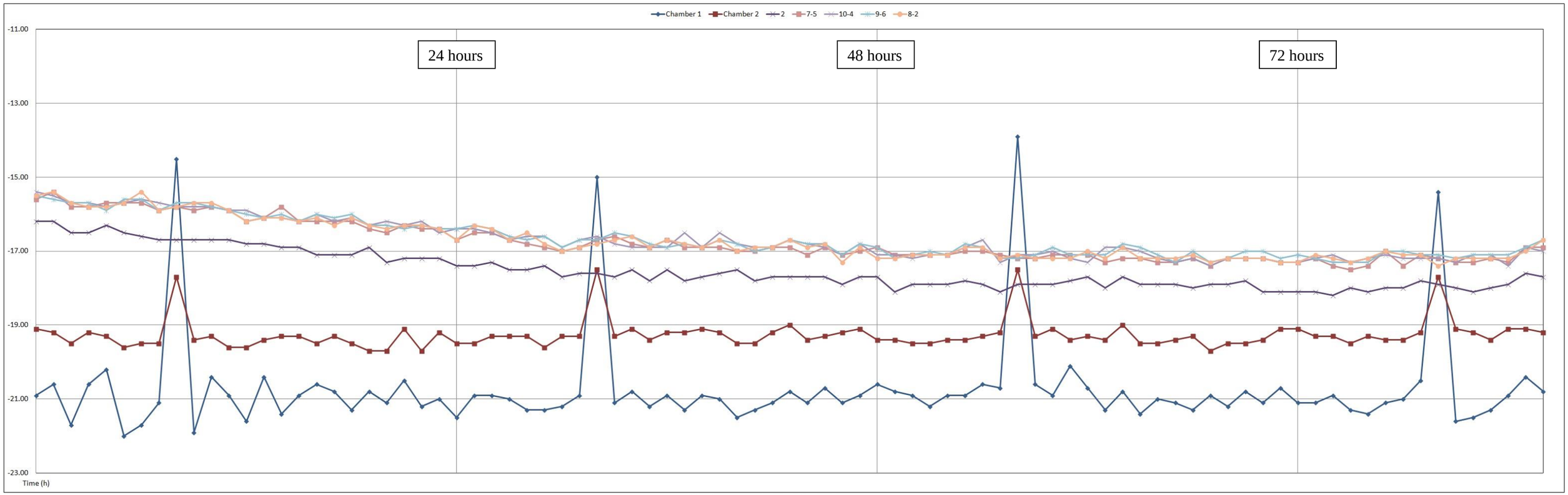


**Figure C3. Graph of rigid IBC Tier 2 thermocouples**

## 11.4. Temperature vs. Time – Rigid IBC (Tier 3)

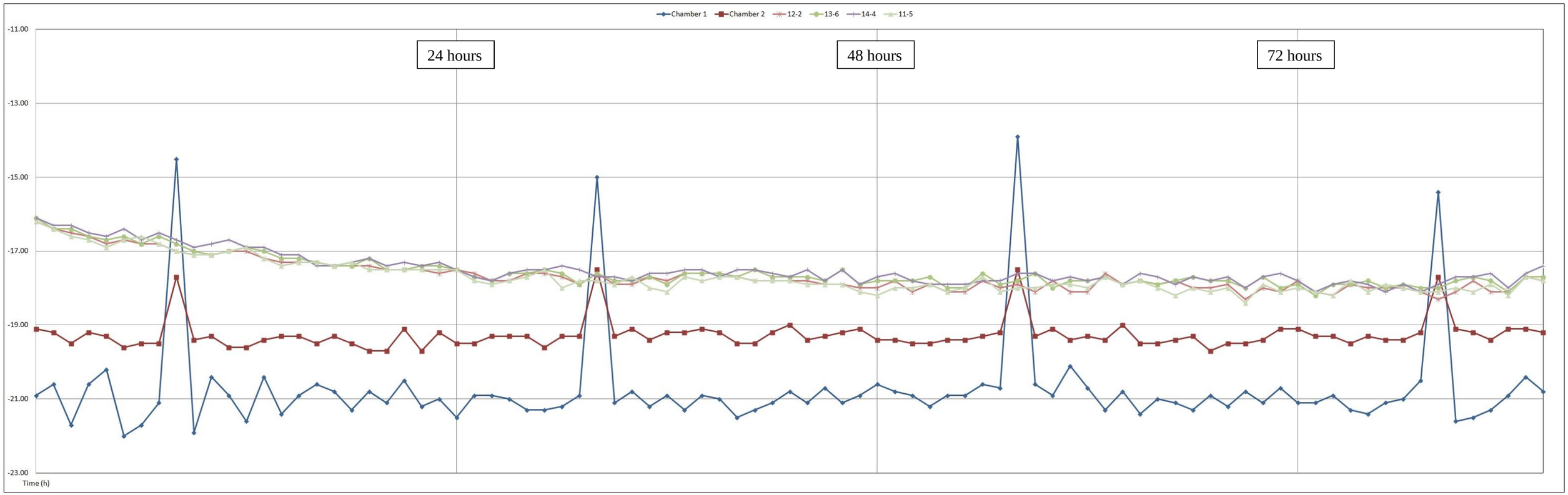


**Figure C4. Graph of rigid IBC Tier 3 thermocouples**

## 11.5. Temperature vs. Time – Rigid IBC (Internal)

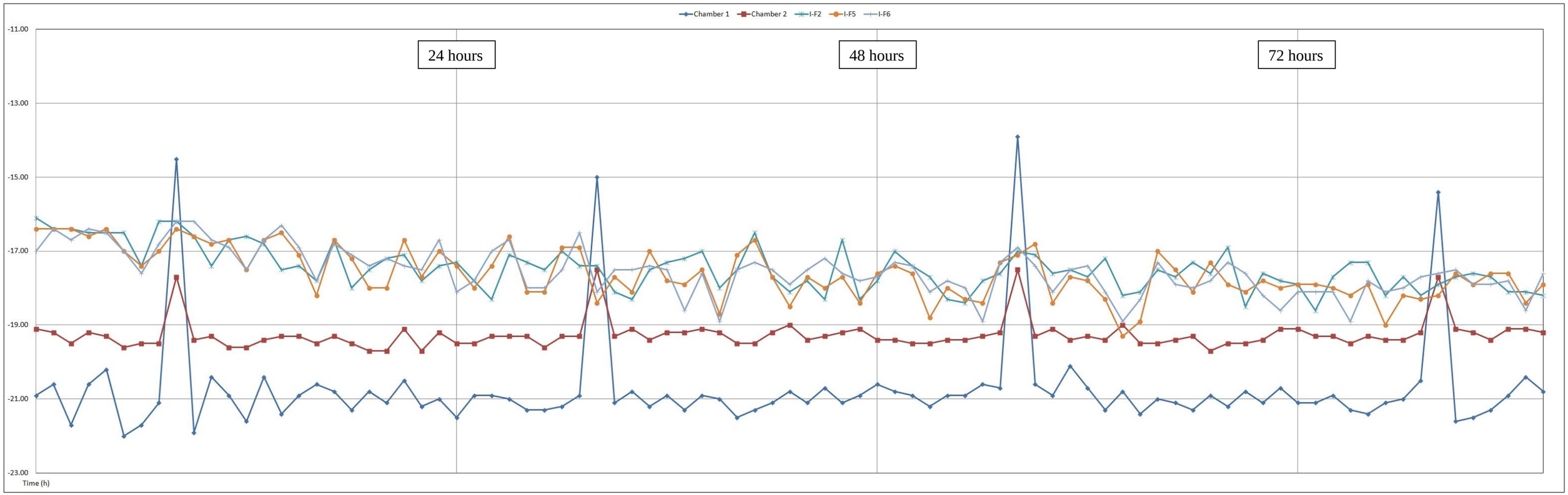


**Figure C5. Graph of rigid IBC Internal thermocouples**

## 11.6. Temperature vs. Time – Rigid IBC (External)

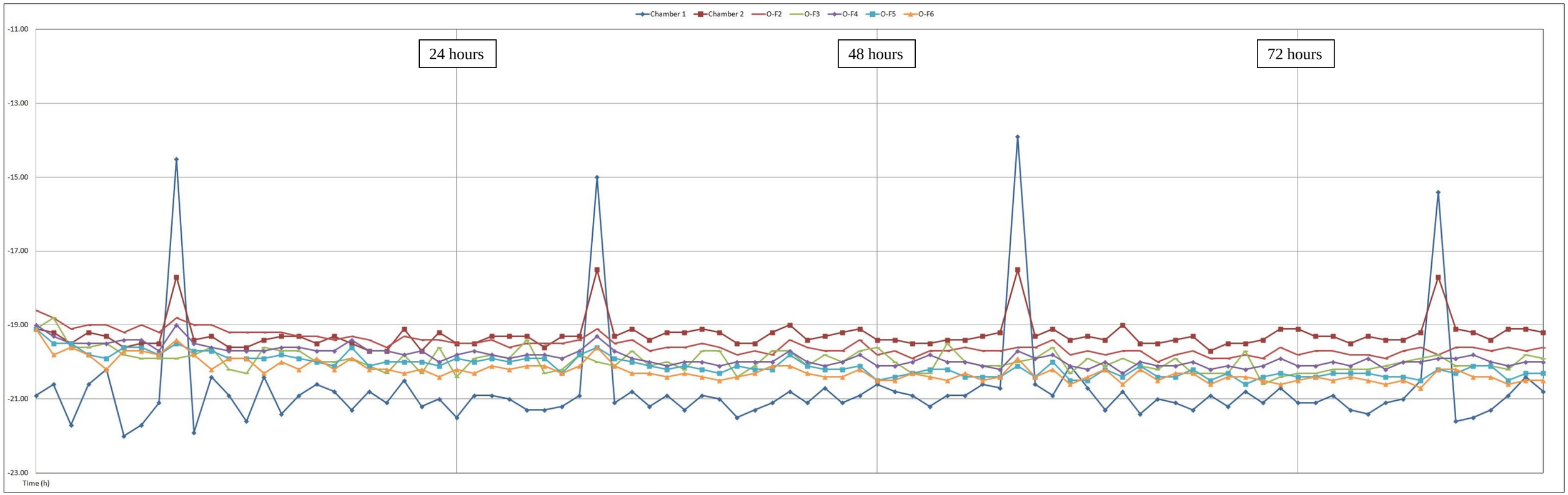


**Figure C6. Graph of rigid IBC External thermocouples**

## 11.7. Temperature vs. Time – Composite IBC (All Thermocouples)

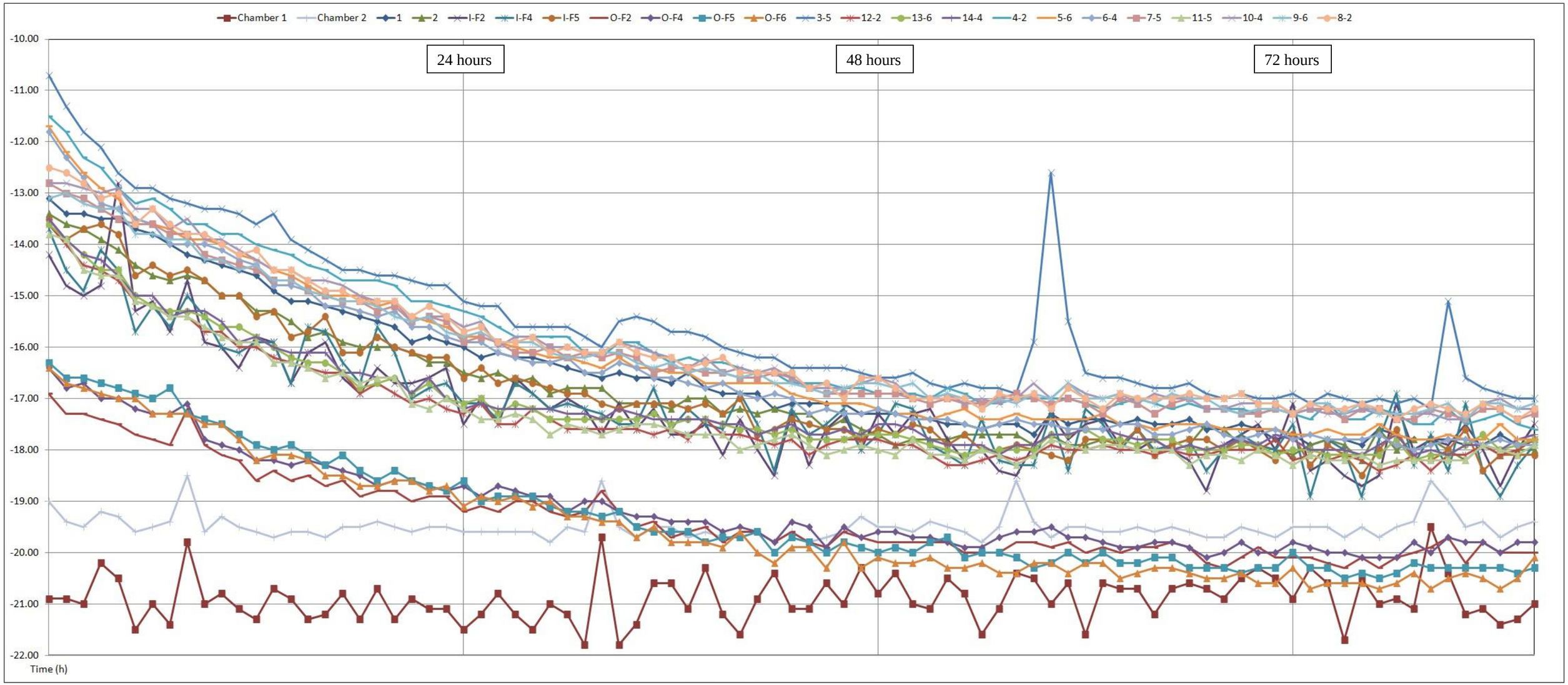


**Figure C7. Combined graph of temperature vs. time for composite IBC**

## 11.8. Temperature vs. Time – Composite IBC (Tier 1)

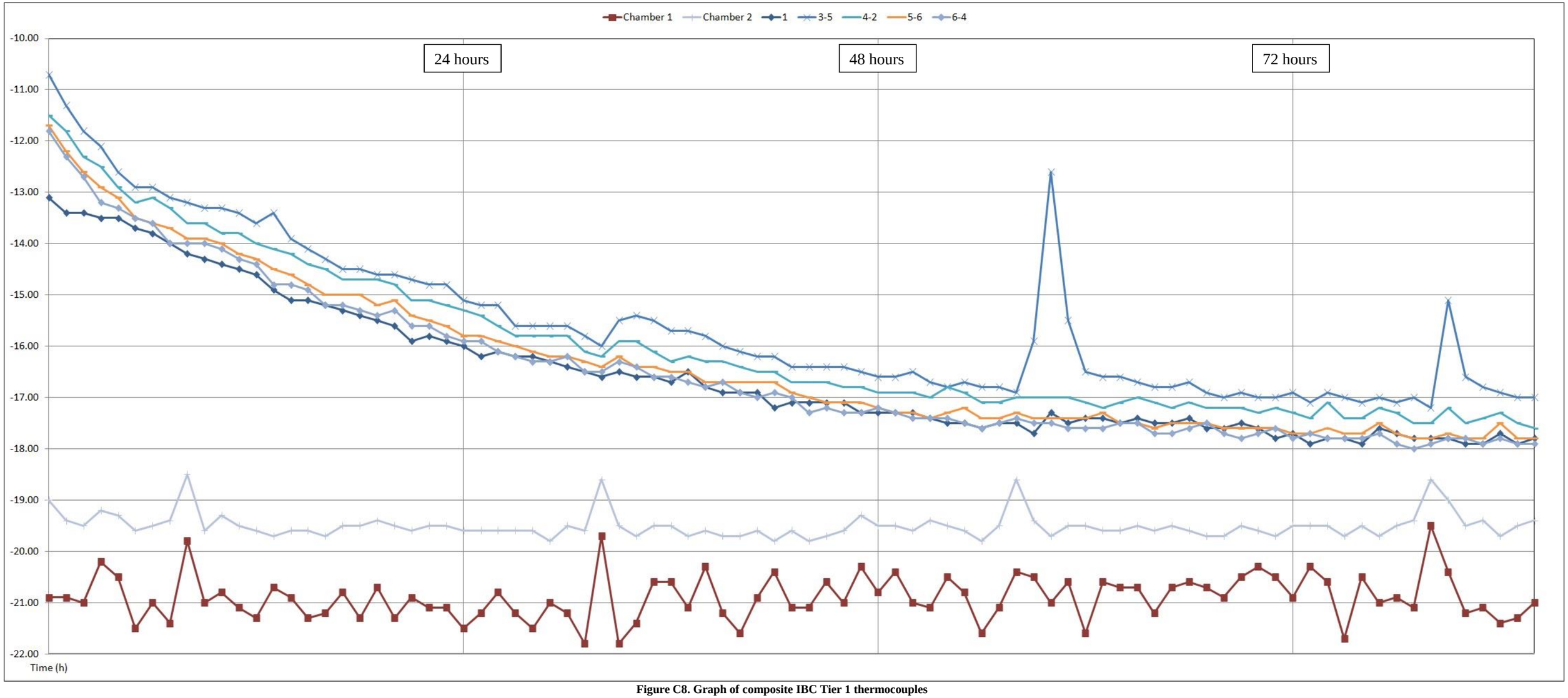


**Figure C8. Graph of composite IBC Tier 1 thermocouples**

## 11.9. Temperature vs. Time – Composite IBC (Tier 2)

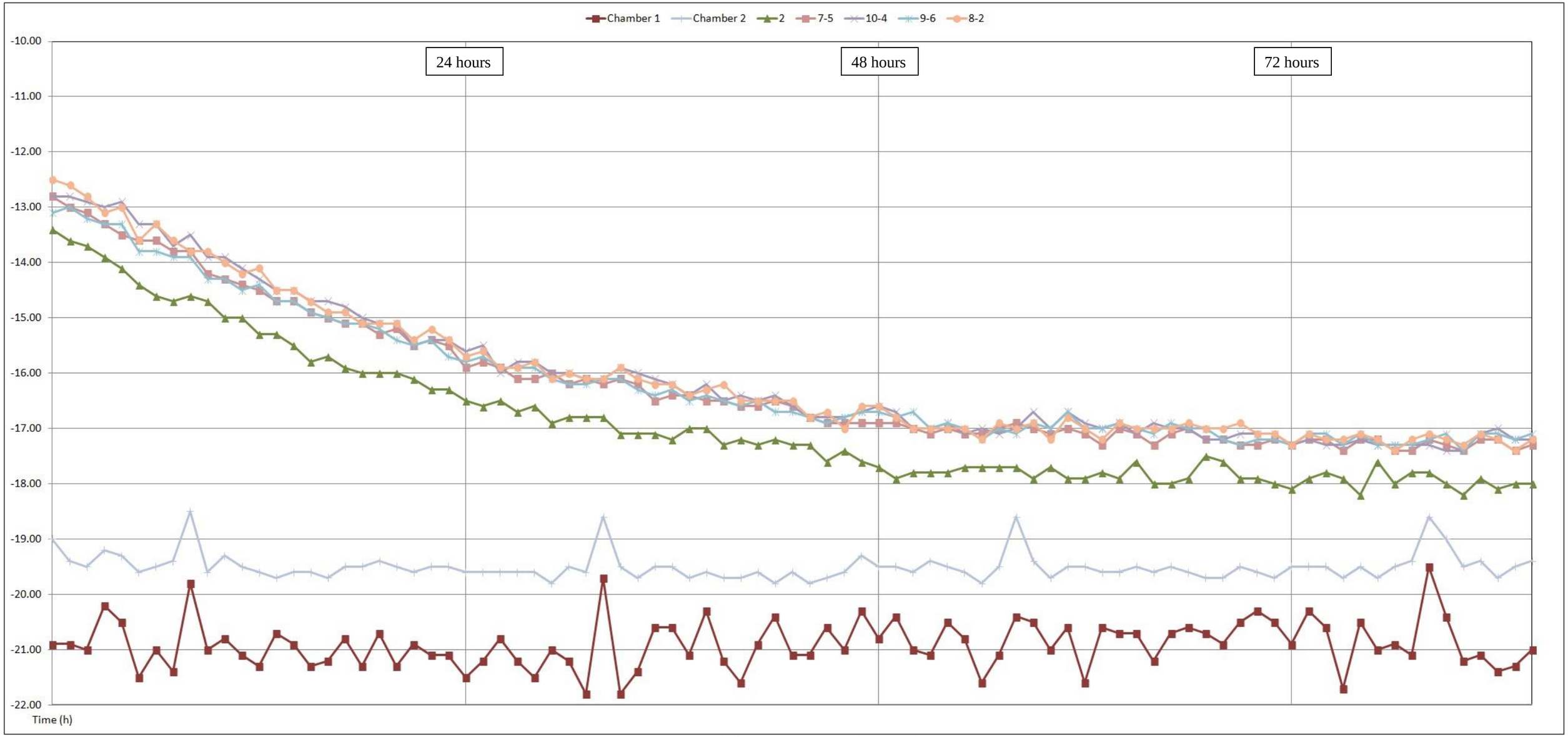


**Figure C9. Graph of composite IBC Tier 2 thermocouples**

## 11.10. Temperature vs. Time – Composite IBC (Tier 3)

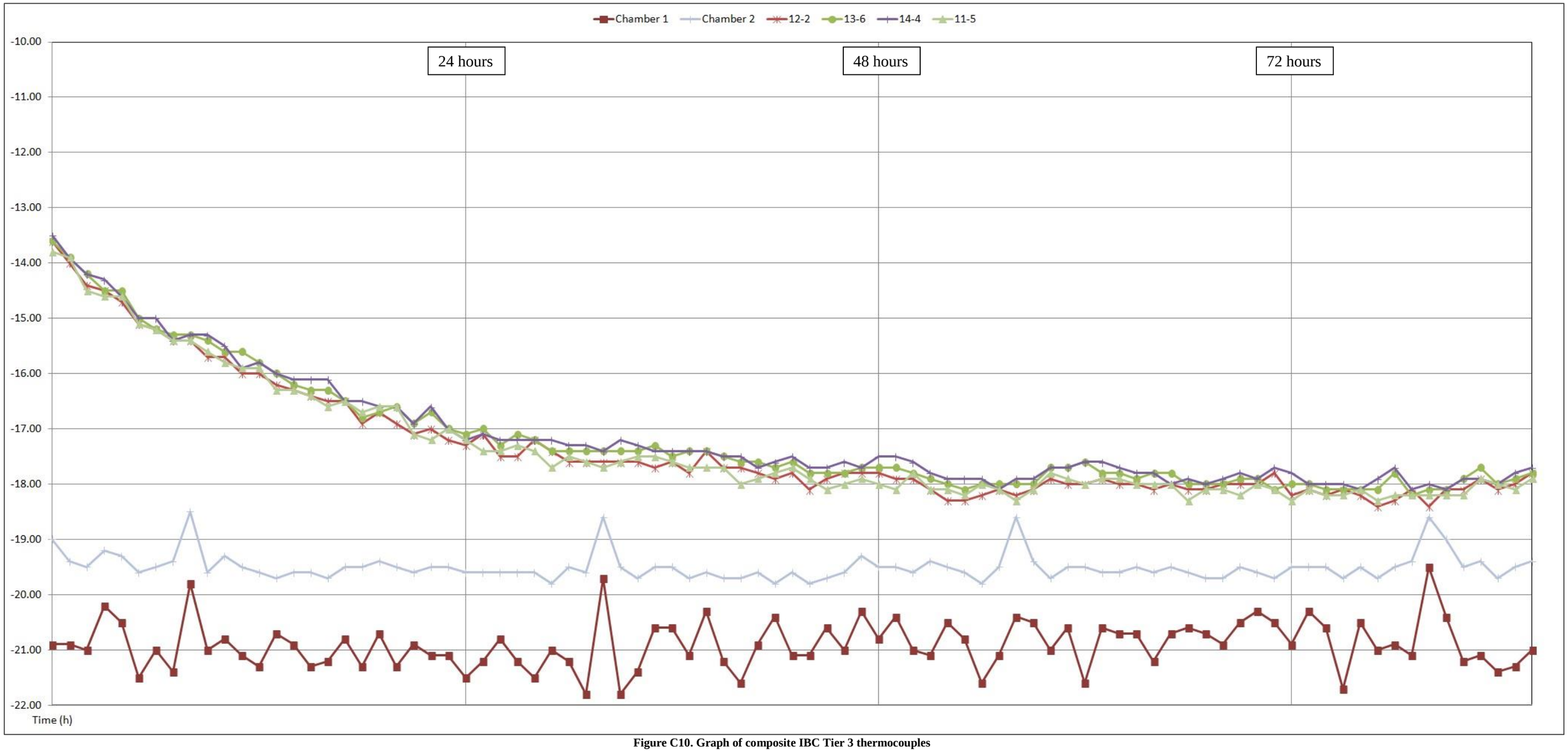


**Figure C10. Graph of composite IBC Tier 3 thermocouples**

## 11.11. Temperature vs. Time – Composite IBC (Internal)

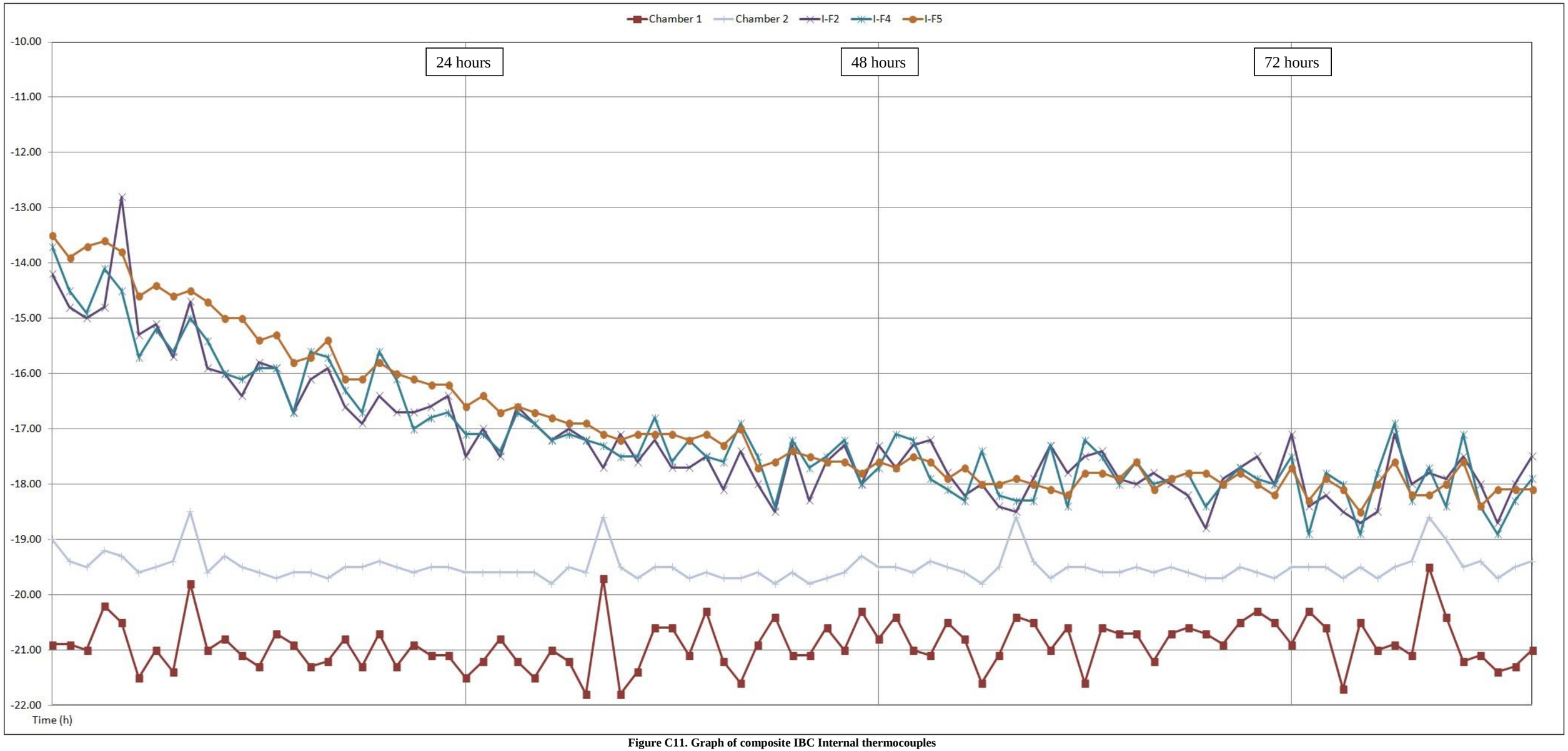


**Figure C11. Graph of composite IBC Internal thermocouples**

## 11.12. Temperature vs. Time – Composite IBC (External)

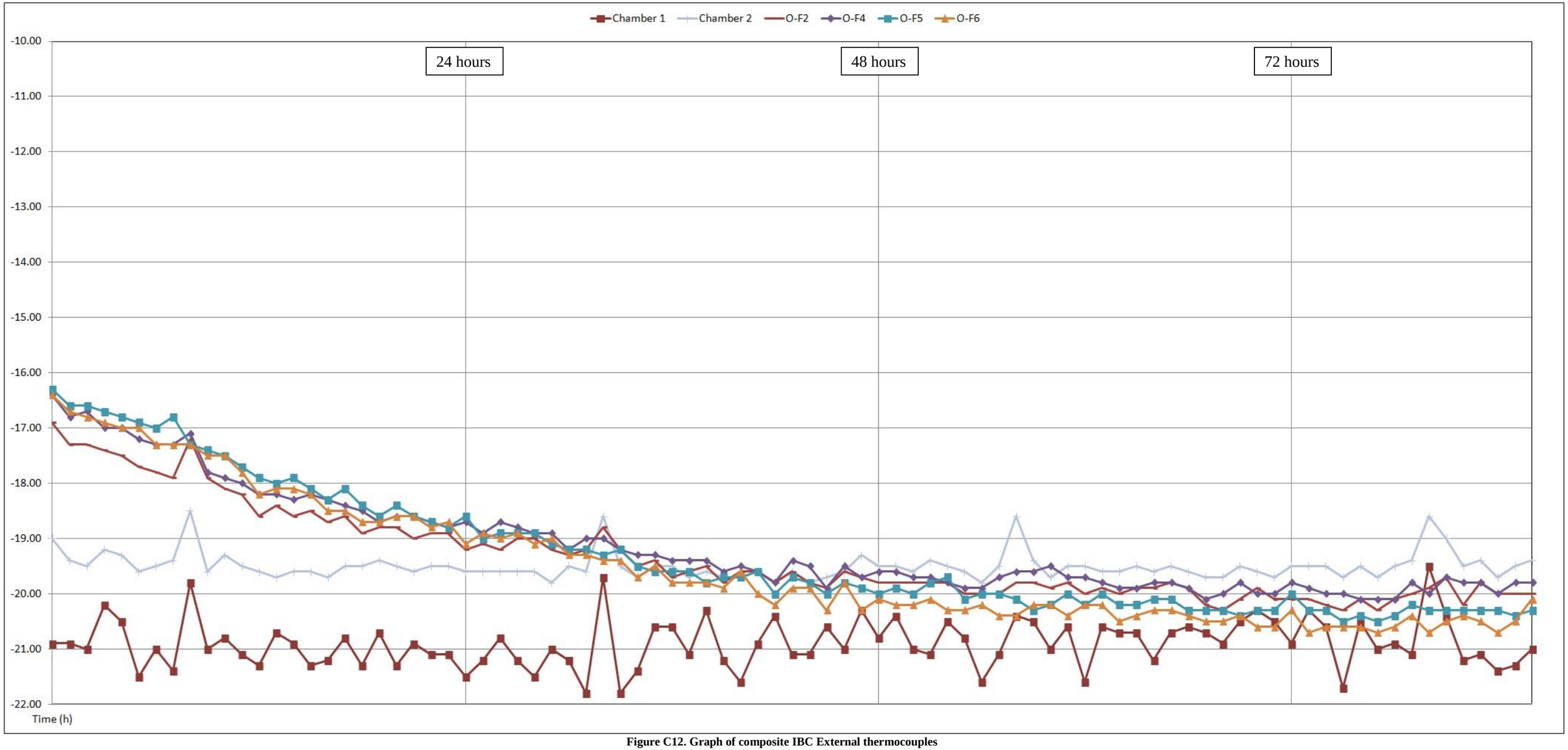


**Figure C12. Graph of composite IBC External thermocouples**

Graphs C13 and C14 in this appendix are three dimensional representations which plot three variables against each other; thermocouple temperature readings, the cooling rate, and conditioning time. Each was created using the Minitab software.

### 11.13. Three Dimensional Contour Graph - Rigid IBC

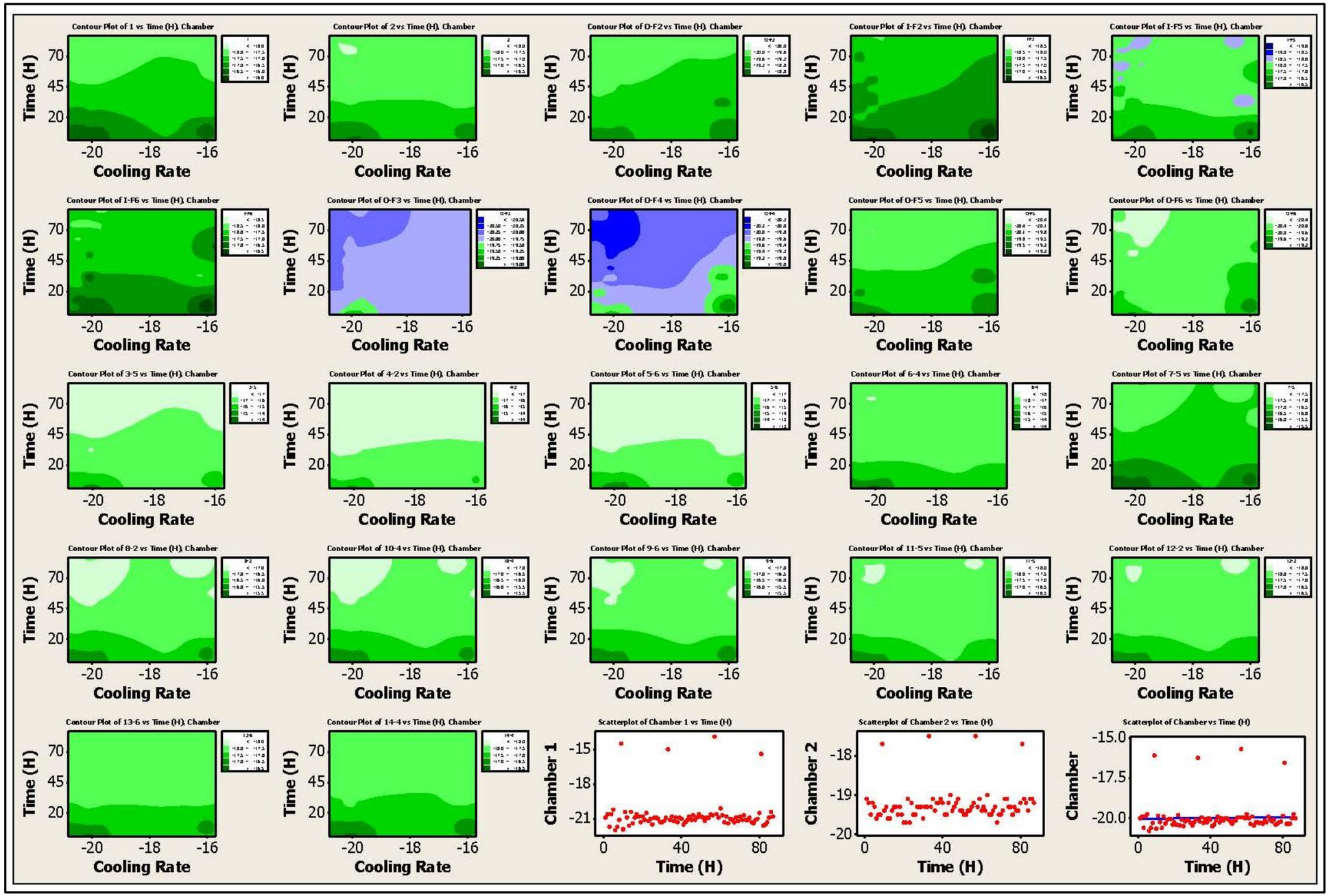


**Figure C13. Three dimensional plot of temperature, cooling rate, and time for rigid IBC**

## 11.14. Three Dimensional Contour Graph - Composite IBC

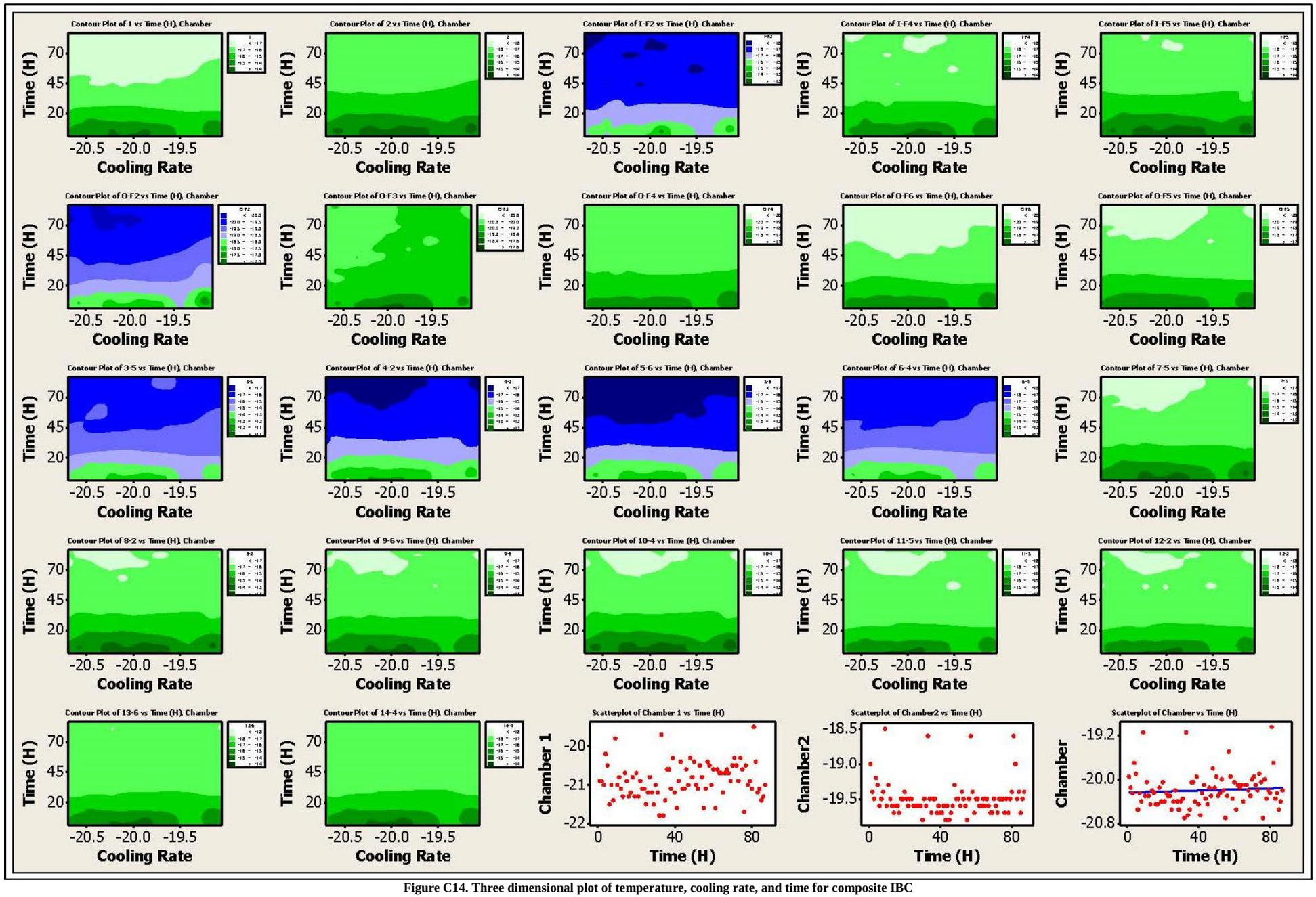


**Figure C14. Three dimensional plot of temperature, cooling rate, and time for composite IBC**

## 12. Appendix D – Conditioning Data

The tables in this appendix contain the data for the rigid and composite IBCs before reduction and normalization. The data is broken down into 24 hour intervals.

### 12.1. Rigid IBC Data

Due to an unknown malfunction, channel I-F4 did not correctly measure the temperature values. As a result, data collected from this channel was not used for analysis.

| Time (Hrs) | Chamber | | Mid-Tier | | Internal Walls | | | | Outer Walls | | | | | Tier 1 | | | | Tier 2 | | | | Tier 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chamber 1 | Chamber 2 | 1 | 2 | I-F2 | I-F4 | I-F5 | I-F6 | O-F2 | O-F3 | O-F4 | O-F5 | O-F6 | 3-5 | 4-2 | 5-6 | 6-4 | 7-5 | 8-2 | 9-6 | 10-4 | 11-5 | 12-2 | 13-6 | 14-4 |
| 1 | -20.90 | -19.10 | -15.90 | -16.20 | -16.10 | -3276.80 | -16.40 | -17.00 | -18.60 | -19.10 | -19.00 | -19.10 | -19.10 | -13.70 | -14.00 | -12.80 | -13.70 | -15.60 | -15.50 | -15.50 | -15.40 | -16.20 | -16.20 | -16.10 | -16.10 |
| 2 | -20.60 | -19.20 | -16.00 | -16.20 | -16.40 | -3276.80 | -16.40 | -16.40 | -18.80 | -18.80 | -19.30 | -19.50 | -19.80 | -14.20 | -14.40 | -13.50 | -14.40 | -15.40 | -15.40 | -15.60 | -15.50 | -16.40 | -16.40 | -16.40 | -16.30 |
| 3 | -21.70 | -19.50 | -16.20 | -16.50 | -16.40 | -3276.80 | -16.40 | -16.70 | -19.10 | -19.60 | -19.50 | -19.50 | -19.60 | -14.60 | -14.90 | -14.20 | -14.90 | -15.80 | -15.70 | -15.70 | -15.70 | -16.60 | -16.50 | -16.40 | -16.30 |
| 4 | -20.60 | -19.20 | -16.10 | -16.50 | -16.50 | -3276.80 | -16.60 | -16.40 | -19.00 | -19.60 | -19.50 | -19.80 | -19.80 | -15.00 | -15.30 | -14.50 | -15.20 | -15.80 | -15.80 | -15.70 | -15.70 | -16.70 | -16.60 | -16.60 | -16.50 |
| 5 | -20.20 | -19.30 | -16.10 | -16.30 | -16.50 | -3276.80 | -16.40 | -16.50 | -19.00 | -19.50 | -19.50 | -19.90 | -20.20 | -15.30 | -15.40 | -14.70 | -15.40 | -15.70 | -15.80 | -15.90 | -15.80 | -16.90 | -16.80 | -16.70 | -16.60 |
| 6 | -22.00 | -19.60 | -16.30 | -16.50 | -16.50 | -3276.80 | -17.00 | -17.00 | -19.20 | -19.80 | -19.40 | -19.60 | -19.70 | -15.30 | -15.60 | -14.90 | -15.60 | -15.70 | -15.70 | -15.60 | -15.70 | -16.70 | -16.70 | -16.60 | -16.40 |
| 7 | -21.70 | -19.50 | -16.10 | -16.60 | -17.40 | -3276.80 | -17.40 | -17.60 | -19.00 | -19.90 | -19.40 | -19.60 | -19.70 | -15.50 | -15.80 | -15.30 | -15.70 | -15.70 | -15.40 | -15.60 | -15.60 | -16.60 | -16.80 | -16.80 | -16.70 |
| 8 | -21.10 | -19.50 | -16.30 | -16.70 | -16.20 | -3276.80 | -17.00 | -16.80 | -19.20 | -19.90 | -19.70 | -19.80 | -19.80 | -15.50 | -16.00 | -15.40 | -16.00 | -15.90 | -15.90 | -15.90 | -15.70 | -16.80 | -16.80 | -16.60 | -16.50 |
| 9 | -14.50 | -17.70 | -16.20 | -16.70 | -16.20 | -3276.80 | -16.40 | -16.20 | -18.80 | -19.90 | -19.00 | -19.50 | -19.40 | -15.60 | -15.90 | -15.70 | -16.10 | -15.80 | -15.80 | -15.70 | -15.80 | -17.00 | -17.00 | -16.80 | -16.70 |
| 10 | -21.90 | -19.40 | -16.30 | -16.70 | -16.60 | -3276.80 | -16.60 | -16.20 | -19.00 | -19.80 | -19.50 | -19.70 | -19.80 | -15.80 | -16.30 | -15.70 | -16.30 | -15.90 | -15.70 | -15.70 | -15.80 | -17.10 | -17.10 | -17.00 | -16.90 |
| 11 | -20.40 | -19.30 | -16.30 | -16.70 | -17.40 | -3276.80 | -16.80 | -16.70 | -19.00 | -19.60 | -19.60 | -19.70 | -20.20 | -15.80 | -16.20 | -15.60 | -16.20 | -15.80 | -15.70 | -15.80 | -15.80 | -17.10 | -17.10 | -17.10 | -16.80 |
| 12 | -20.90 | -19.60 | -16.30 | -16.70 | -16.70 | -3276.80 | -16.70 | -16.90 | -19.20 | -20.20 | -19.70 | -19.90 | -19.90 | -15.30 | -16.40 | -15.60 | -16.40 | -15.90 | -15.90 | -15.90 | -15.90 | -17.00 | -17.00 | -17.00 | -16.70 |
| 13 | -21.60 | -19.60 | -16.40 | -16.80 | -16.60 | -3276.80 | -17.50 | -17.50 | -19.20 | -20.30 | -19.70 | -19.90 | -19.90 | -15.60 | -16.50 | -15.90 | -16.60 | -16.20 | -16.20 | -16.00 | -15.90 | -16.90 | -17.00 | -16.90 | -16.90 |
| 14 | -20.40 | -19.40 | -16.40 | -16.80 | -16.80 | -3276.80 | -16.70 | -16.70 | -19.20 | -19.60 | -19.70 | -19.90 | -20.30 | -16.00 | -16.30 | -15.90 | -16.50 | -16.10 | -16.10 | -16.10 | -16.10 | -17.20 | -17.20 | -17.00 | -16.90 |
| 15 | -21.40 | -19.30 | -16.30 | -16.90 | -17.50 | -3276.80 | -16.50 | -16.30 | -19.20 | -19.70 | -19.60 | -19.80 | -20.00 | -16.00 | -16.40 | -15.90 | -16.50 | -15.80 | -16.10 | -16.00 | -16.10 | -17.40 | -17.30 | -17.20 | -17.10 |
| 16 | -20.90 | -19.30 | -16.60 | -16.90 | -17.40 | -3276.80 | -17.10 | -16.90 | -19.30 | -19.70 | -19.60 | -19.90 | -20.20 | -16.20 | -16.60 | -16.20 | -16.80 | -16.20 | -16.20 | -16.20 | -16.20 | -17.30 | -17.30 | -17.20 | -17.10 |
| 17 | -20.60 | -19.50 | -16.80 | -17.10 | -17.80 | -3276.80 | -18.20 | -17.80 | -19.30 | -20.00 | -19.70 | -20.00 | -19.90 | -16.50 | -16.70 | -16.50 | -16.90 | -16.20 | -16.10 | -16.00 | -16.00 | -17.30 | -17.30 | -17.30 | -17.40 |
| 18 | -20.80 | -19.30 | -16.60 | -17.10 | -16.70 | -3276.80 | -16.70 | -16.80 | -19.40 | -20.00 | -19.70 | -20.10 | -20.20 | -16.40 | -16.60 | -16.40 | -16.80 | -16.20 | -16.30 | -16.10 | -16.20 | -17.40 | -17.40 | -17.40 | -17.40 |
| 19 | -21.30 | -19.50 | -16.80 | -17.10 | -18.00 | -3276.80 | -17.20 | -17.10 | -19.30 | -19.90 | -19.40 | -19.60 | -19.90 | -16.50 | -16.80 | -16.50 | -16.90 | -16.20 | -16.10 | -16.00 | -16.10 | -17.30 | -17.40 | -17.40 | -17.30 |
| 20 | -20.80 | -19.70 | -16.70 | -16.90 | -17.50 | -3276.80 | -18.00 | -17.40 | -19.40 | -20.10 | -19.70 | -20.10 | -20.20 | -16.60 | -16.90 | -16.70 | -17.00 | -16.40 | -16.30 | -16.30 | -16.30 | -17.50 | -17.40 | -17.20 | -17.20 |
| 21 | -21.10 | -19.70 | -16.90 | -17.30 | -17.20 | -3276.80 | -18.00 | -17.20 | -19.60 | -20.30 | -19.70 | -20.00 | -20.20 | -16.60 | -17.00 | -16.70 | -17.00 | -16.50 | -16.40 | -16.30 | -16.20 | -17.50 | -17.50 | -17.50 | -17.40 |
| 22 | -20.50 | -19.10 | -16.80 | -17.20 | -17.10 | -3276.80 | -16.70 | -17.40 | -19.30 | -19.80 | -19.80 | -20.00 | -20.30 | -16.50 | -16.90 | -16.50 | -17.00 | -16.30 | -16.30 | -16.40 | -16.30 | -17.50 | -17.50 | -17.50 | -17.30 |
| 23 | -21.20 | -19.70 | -16.90 | -17.20 | -17.80 | -3276.80 | -17.70 | -17.50 | -19.40 | -20.30 | -19.70 | -20.00 | -20.20 | -16.60 | -17.00 | -16.70 | -17.20 | -16.40 | -16.30 | -16.30 | -16.20 | -17.50 | -17.50 | -17.40 | -17.40 |
| 24 | -21.00 | -19.20 | -17.00 | -17.20 | -17.40 | -3276.80 | -17.00 | -16.70 | -19.40 | -19.60 | -20.00 | -20.10 | -20.40 | -16.70 | -16.80 | -16.70 | -17.10 | -16.40 | -16.40 | -16.40 | -16.50 | -17.50 | -17.60 | -17.40 | -17.30 |

| Time (Hrs) | Chamber | | Mid-Tier | | Internal Walls | | | | Outer Walls | | | | | Tier 1 | | | | Tier 2 | | | | Tier 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chamber 1 | Chamber 2 | 1 | 2 | I-F2 | I-F4 | I-F5 | I-F6 | O-F2 | O-F3 | O-F4 | O-F5 | O-F6 | 3-5 | 4-2 | 5-6 | 6-4 | 7-5 | 8-2 | 9-6 | 10-4 | 11-5 | 12-2 | 13-6 | 14-4 |
| 25 | -21.50 | -19.50 | -16.60 | -17.40 | -17.30 | -3276.80 | -17.40 | -18.10 | -19.50 | -20.40 | -19.80 | -19.90 | -20.20 | -16.80 | -17.00 | -16.90 | -17.10 | -16.70 | -16.70 | -16.40 | -16.40 | -17.50 | -17.50 | -17.50 | -17.50 |
| 26 | -20.90 | -19.50 | -17.10 | -17.40 | -17.80 | -3276.80 | -18.00 | -17.80 | -19.50 | -19.90 | -19.70 | -20.00 | -20.30 | -16.90 | -16.90 | -16.90 | -17.10 | -16.50 | -16.30 | -16.30 | -16.40 | -17.80 | -17.60 | -17.70 | -17.70 |
| 27 | -20.90 | -19.30 | -17.00 | -17.30 | -18.30 | -3276.80 | -17.40 | -17.00 | -19.40 | -19.80 | -19.80 | -19.90 | -20.10 | -16.90 | -16.90 | -16.90 | -17.20 | -16.50 | -16.40 | -16.40 | -16.50 | -17.90 | -17.80 | -17.80 | -17.80 |
| 28 | -21.00 | -19.30 | -17.10 | -17.50 | -17.10 | -3276.80 | -16.60 | -16.70 | -19.60 | -19.90 | -19.90 | -20.00 | -20.20 | -16.90 | -17.00 | -16.90 | -17.20 | -16.70 | -16.70 | -16.60 | -16.70 | -17.80 | -17.80 | -17.60 | -17.60 |
| 29 | -21.30 | -19.30 | -17.10 | -17.50 | -17.30 | -3276.80 | -18.10 | -18.00 | -19.50 | -19.40 | -19.80 | -19.90 | -20.10 | -17.00 | -17.00 | -17.00 | -17.40 | -16.80 | -16.50 | -16.70 | -16.60 | -17.70 | -17.60 | -17.60 | -17.50 |
| 30 | -21.30 | -19.60 | -17.40 | -17.40 | -17.50 | -3276.80 | -18.10 | -18.00 | -19.50 | -20.30 | -19.80 | -19.90 | -20.10 | -16.90 | -17.30 | -17.10 | -17.50 | -16.90 | -16.80 | -16.60 | -16.60 | -17.50 | -17.60 | -17.50 | -17.50 |
| 31 | -21.20 | -19.30 | -17.30 | -17.70 | -17.00 | -3276.80 | -16.90 | -17.50 | -19.50 | -20.20 | -19.90 | -20.30 | -20.30 | -16.90 | -17.00 | -17.10 | -17.50 | -17.00 | -17.00 | -16.90 | -16.90 | -18.00 | -17.70 | -17.60 | -17.40 |
| 32 | -20.90 | -19.30 | -17.20 | -17.60 | -17.40 | -3276.80 | -16.90 | -16.50 | -19.40 | -19.80 | -19.70 | -19.80 | -20.10 | -17.10 | -17.20 | -17.10 | -17.50 | -16.90 | -16.90 | -16.70 | -16.70 | -17.80 | -17.90 | -17.90 | -17.50 |
| 33 | -15.00 | -17.50 | -17.50 | -17.60 | -17.40 | -3276.80 | -18.40 | -18.10 | -19.10 | -20.00 | -19.30 | -19.60 | -19.60 | -17.00 | -17.00 | -17.20 | -17.40 | -16.70 | -16.80 | -16.70 | -16.60 | -17.80 | -17.60 | -17.60 | -17.70 |
| 34 | -21.10 | -19.30 | -17.30 | -17.70 | -18.10 | -3276.80 | -17.70 | -17.50 | -19.50 | -20.10 | -19.70 | -19.90 | -20.10 | -16.70 | -16.90 | -16.80 | -17.20 | -16.60 | -16.70 | -16.50 | -16.80 | -17.90 | -17.90 | -17.80 | -17.70 |
| 35 | -20.80 | -19.10 | -17.40 | -17.50 | -18.30 | -3276.80 | -18.10 | -17.50 | -19.40 | -19.70 | -19.90 | -20.00 | -20.30 | -16.80 | -17.00 | -16.90 | -17.30 | -16.80 | -16.60 | -16.60 | -16.90 | -17.70 | -17.90 | -17.80 | -17.80 |
| 36 | -21.20 | -19.40 | -17.30 | -17.80 | -17.50 | -3276.80 | -17.00 | -17.40 | -19.70 | -20.10 | -20.00 | -20.10 | -20.30 | -16.80 | -17.20 | -17.00 | -17.50 | -16.90 | -16.90 | -16.80 | -16.90 | -18.00 | -17.70 | -17.70 | -17.60 |
| 37 | -20.90 | -19.20 | -17.40 | -17.50 | -17.30 | -3276.80 | -17.80 | -17.50 | -19.60 | -20.00 | -20.10 | -20.20 | -20.40 | -16.90 | -17.00 | -17.00 | -17.40 | -16.70 | -16.70 | -16.90 | -16.90 | -18.10 | -17.80 | -17.90 | -17.60 |
| 38 | -21.30 | -19.20 | -17.50 | -17.80 | -17.20 | -3276.80 | -17.90 | -18.60 | -19.60 | -20.20 | -20.00 | -20.10 | -20.30 | -16.80 | -17.20 | -17.10 | -17.40 | -16.90 | -16.80 | -16.80 | -16.50 | -17.70 | -17.60 | -17.60 | -17.50 |
| 39 | -20.90 | -19.10 | -17.30 | -17.70 | -17.00 | -3276.80 | -17.50 | -17.60 | -19.50 | -19.70 | -20.00 | -20.20 | -20.40 | -16.90 | -17.20 | -17.20 | -17.50 | -16.90 | -16.90 | -16.90 | -16.90 | -17.80 | -17.60 | -17.60 | -17.50 |
| 40 | -21.00 | -19.20 | -17.70 | -17.60 | -18.00 | -3276.80 | -18.70 | -18.90 | -19.60 | -19.70 | -20.10 | -20.30 | -20.50 | -17.00 | -17.30 | -17.30 | -17.50 | -16.90 | -16.70 | -16.70 | -16.50 | -17.70 | -17.60 | -17.60 | -17.70 |
| 41 | -21.50 | -19.50 | -17.40 | -17.50 | -17.50 | -3276.80 | -17.10 | -17.50 | -19.80 | -20.40 | -20.00 | -20.10 | -20.40 | -17.00 | -17.30 | -17.30 | -17.60 | -17.00 | -17.00 | -16.80 | -16.80 | -17.70 | -17.70 | -17.70 | -17.50 |
| 42 | -21.30 | -19.50 | -17.40 | -17.80 | -16.50 | -3276.80 | -16.70 | -17.30 | -19.70 | -20.10 | -20.00 | -20.20 | -20.30 | -16.90 | -17.30 | -17.30 | -17.50 | -17.00 | -16.90 | -17.00 | -16.90 | -17.80 | -17.80 | -17.50 | -17.50 |
| 43 | -21.10 | -19.20 | -17.30 | -17.70 | -17.70 | -3276.80 | -17.70 | -17.50 | -19.80 | -19.70 | -20.00 | -20.20 | -20.10 | -17.10 | -17.10 | -17.20 | -17.70 | -16.90 | -16.90 | -16.90 | -16.90 | -17.80 | -17.80 | -17.70 | -17.60 |
| 44 | -20.80 | -19.00 | -17.50 | -17.70 | -18.10 | -3276.80 | -18.50 | -17.90 | -19.40 | -19.70 | -19.70 | -19.80 | -20.10 | -17.10 | -17.20 | -17.40 | -17.60 | -16.90 | -16.70 | -16.70 | -16.70 | -17.80 | -17.80 | -17.70 | -17.70 |
| 45 | -21.10 | -19.40 | -17.40 | -17.70 | -17.80 | -3276.80 | -17.70 | -17.50 | -19.60 | -20.10 | -20.00 | -20.10 | -20.30 | -17.00 | -17.20 | -17.30 | -17.60 | -17.10 | -16.90 | -16.80 | -16.80 | -17.90 | -17.80 | -17.70 | -17.50 |
| 46 | -20.70 | -19.30 | -17.50 | -17.70 | -18.30 | -3276.80 | -18.00 | -17.20 | -19.70 | -19.80 | -20.10 | -20.20 | -20.40 | -17.10 | -17.20 | -17.30 | -17.60 | -16.90 | -16.80 | -16.80 | -16.90 | -17.90 | -17.90 | -17.80 | -17.80 |
| 47 | -21.10 | -19.20 | -17.50 | -17.90 | -16.70 | -3276.80 | -17.70 | -17.60 | -19.70 | -20.00 | -20.00 | -20.20 | -20.40 | -17.00 | -17.20 | -17.40 | -17.80 | -17.10 | -17.30 | -17.10 | -17.10 | -17.90 | -17.90 | -17.50 | -17.50 |
| 48 | -20.90 | -19.10 | -17.60 | -17.70 | -18.30 | -3276.80 | -18.40 | -17.80 | -19.40 | -19.70 | -19.80 | -20.10 | -20.20 | -17.30 | -17.40 | -17.50 | -17.60 | -17.00 | -16.90 | -16.80 | -16.80 | -18.10 | -18.00 | -17.90 | -17.90 |

| Time (Hrs) | Chamber | | Mid-Tier | | Internal Walls | | | | Outer Walls | | | | | Tier 1 | | | | Tier 2 | | | | Tier 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chamber 1 | Chamber 2 | 1 | 2 | I-F2 | I-F4 | I-F5 | I-F6 | O-F2 | O-F3 | O-F4 | O-F5 | O-F6 | 3-5 | 4-2 | 5-6 | 6-4 | 7-5 | 8-2 | 9-6 | 10-4 | 11-5 | 12-2 | 13-6 | 14-4 |
| 49 | -20.60 | -19.40 | -17.50 | -17.70 | -17.80 | -3276.80 | -17.60 | -17.70 | -19.80 | -19.60 | -20.10 | -20.50 | -20.50 | -17.20 | -17.30 | -17.50 | -17.70 | -16.90 | -17.20 | -16.90 | -17.10 | -18.20 | -18.00 | -17.80 | -17.70 |
| 50 | -20.80 | -19.40 | -17.60 | -18.10 | -17.00 | -3276.80 | -17.40 | -17.30 | -19.70 | -20.00 | -20.10 | -20.40 | -20.50 | -17.20 | -17.40 | -17.50 | -17.70 | -17.10 | -17.20 | -17.20 | -17.10 | -18.00 | -17.80 | -17.80 | -17.60 |
| 51 | -20.90 | -19.50 | -17.60 | -17.90 | -17.40 | -3276.80 | -17.60 | -17.40 | -19.90 | -20.30 | -20.00 | -20.30 | -20.30 | -17.30 | -17.30 | -17.50 | -17.70 | -17.10 | -17.10 | -17.10 | -17.20 | -18.00 | -18.10 | -17.80 | -17.80 |
| 52 | -21.20 | -19.50 | -17.70 | -17.90 | -17.70 | -3276.80 | -18.80 | -18.10 | -19.70 | -20.30 | -19.80 | -20.20 | -20.40 | -17.30 | -17.50 | -17.50 | -17.80 | -17.10 | -17.10 | -17.00 | -17.10 | -17.90 | -17.90 | -17.70 | -17.90 |
| 53 | -20.90 | -19.40 | -17.70 | -17.90 | -18.30 | -3276.80 | -18.00 | -17.80 | -19.70 | -19.50 | -20.00 | -20.20 | -20.50 | -17.40 | -17.40 | -17.50 | -17.80 | -17.10 | -17.10 | -17.10 | -17.10 | -18.10 | -18.10 | -18.00 | -17.90 |
| 54 | -20.90 | -19.40 | -17.70 | -17.80 | -18.40 | -3276.80 | -18.30 | -18.00 | -19.60 | -20.00 | -20.00 | -20.40 | -20.30 | -17.40 | -17.30 | -17.50 | -17.70 | -17.00 | -16.90 | -16.80 | -16.90 | -18.00 | -18.10 | -18.00 | -17.90 |
| 55 | -20.60 | -19.30 | -17.90 | -17.90 | -17.80 | -3276.80 | -18.40 | -18.90 | -19.70 | -20.10 | -20.10 | -20.40 | -20.50 | -17.40 | -17.40 | -17.60 | -17.70 | -17.00 | -16.90 | -16.90 | -16.70 | -17.70 | -17.80 | -17.60 | -17.80 |
| 56 | -20.70 | -19.20 | -17.70 | -18.10 | -17.60 | -3276.80 | -17.30 | -17.30 | -19.70 | -20.10 | -20.20 | -20.40 | -20.40 | -17.30 | -17.30 | -17.60 | -17.70 | -17.10 | -17.20 | -17.20 | -17.30 | -18.10 | -18.00 | -17.90 | -17.80 |
| 57 | -13.90 | -17.50 | -17.70 | -17.90 | -17.00 | -3276.80 | -17.10 | -16.90 | -19.60 | -20.00 | -19.70 | -20.10 | -19.90 | -17.30 | -17.40 | -17.60 | -17.70 | -17.20 | -17.10 | -17.20 | -17.10 | -18.00 | -17.90 | -17.80 | -17.60 |
| 58 | -20.60 | -19.30 | -17.60 | -17.90 | -17.10 | -3276.80 | -16.80 | -17.40 | -19.60 | -19.90 | -19.90 | -20.40 | -20.40 | -16.80 | -17.00 | -17.20 | -17.60 | -17.20 | -17.20 | -17.10 | -17.10 | -18.00 | -18.10 | -17.60 | -17.60 |
| 59 | -20.90 | -19.10 | -17.60 | -17.90 | -17.60 | -3276.80 | -18.40 | -18.10 | -19.40 | -19.60 | -19.80 | -20.00 | -20.20 | -17.10 | -17.20 | -17.30 | -17.60 | -17.10 | -17.20 | -16.90 | -17.00 | -17.90 | -17.80 | -18.00 | -17.80 |
| 60 | -20.10 | -19.40 | -17.60 | -17.80 | -17.50 | -3276.80 | -17.70 | -17.50 | -19.80 | -20.30 | -20.10 | -20.50 | -20.60 | -17.00 | -17.10 | -17.30 | -17.60 | -17.10 | -17.20 | -17.10 | -17.20 | -17.90 | -18.10 | -17.80 | -17.70 |
| 61 | -20.70 | -19.30 | -17.60 | -17.70 | -17.70 | -3276.80 | -17.80 | -17.40 | -19.70 | -19.90 | -20.20 | -20.50 | -20.40 | -17.20 | -17.30 | -17.50 | -17.70 | -17.10 | -17.00 | -17.10 | -17.30 | -18.00 | -18.10 | -17.80 | -17.80 |
| 62 | -21.30 | -19.40 | -17.80 | -18.00 | -17.20 | -3276.80 | -18.30 | -18.10 | -19.80 | -20.10 | -20.00 | -20.20 | -20.20 | -17.20 | -17.40 | -17.70 | -17.90 | -17.30 | -17.20 | -17.10 | -16.90 | -17.70 | -17.60 | -17.70 | -17.70 |
| 63 | -20.80 | -19.00 | -18.00 | -17.70 | -18.20 | -3276.80 | -19.30 | -18.90 | -19.70 | -19.90 | -20.30 | -20.40 | -20.60 | -17.40 | -17.40 | -17.60 | -17.80 | -17.20 | -16.90 | -16.80 | -16.90 | -17.90 | -17.90 | -17.90 | -17.90 |
| 64 | -21.40 | -19.50 | -17.80 | -17.90 | -18.10 | -3276.80 | -18.90 | -18.30 | -19.70 | -20.10 | -20.00 | -20.10 | -20.20 | -17.30 | -17.50 | -17.70 | -17.90 | -17.20 | -17.20 | -16.90 | -17.00 | -17.80 | -17.80 | -17.80 | -17.60 |
| 65 | -21.00 | -19.50 | -17.70 | -17.90 | -17.50 | -3276.80 | -17.00 | -17.30 | -20.00 | -20.20 | -20.10 | -20.40 | -20.50 | -17.30 | -17.30 | -17.60 | -17.80 | -17.30 | -17.20 | -17.10 | -17.20 | -18.00 | -17.90 | -17.90 | -17.70 |
| 66 | -21.10 | -19.40 | -17.70 | -17.90 | -17.70 | -3276.80 | -17.50 | -17.90 | -19.80 | -19.90 | -20.10 | -20.40 | -20.30 | -17.30 | -17.40 | -17.80 | -17.90 | -17.30 | -17.20 | -17.30 | -17.30 | -18.20 | -17.80 | -17.80 | -17.90 |
| 67 | -21.30 | -19.30 | -17.80 | -18.00 | -17.30 | -3276.80 | -18.10 | -18.00 | -19.70 | -20.30 | -20.00 | -20.20 | -20.30 | -17.30 | -17.40 | -17.60 | -17.80 | -17.20 | -17.10 | -17.00 | -17.20 | -18.00 | -18.00 | -17.70 | -17.70 |
| 68 | -20.90 | -19.70 | -17.70 | -17.90 | -17.60 | -3276.80 | -17.30 | -17.80 | -19.90 | -20.30 | -20.20 | -20.50 | -20.60 | -17.30 | -17.40 | -17.70 | -17.80 | -17.40 | -17.30 | -17.30 | -17.40 | -18.10 | -18.00 | -17.80 | -17.80 |
| 69 | -21.20 | -19.50 | -17.80 | -17.90 | -16.90 | -3276.80 | -17.90 | -17.30 | -19.90 | -20.30 | -20.10 | -20.30 | -20.40 | -17.40 | -17.40 | -17.60 | -17.90 | -17.20 | -17.20 | -17.20 | -17.20 | -18.00 | -17.90 | -17.80 | -17.70 |
| 70 | -20.80 | -19.50 | -17.70 | -17.80 | -18.50 | -3276.80 | -18.10 | -17.60 | -19.80 | -19.70 | -20.20 | -20.60 | -20.40 | -17.40 | -17.40 | -17.60 | -17.80 | -17.20 | -17.20 | -17.00 | -17.20 | -18.40 | -18.30 | -18.00 | -18.00 |
| 71 | -21.10 | -19.40 | -17.70 | -18.10 | -17.60 | -3276.80 | -17.80 | -18.20 | -19.90 | -20.60 | -20.10 | -20.40 | -20.50 | -17.40 | -17.40 | -17.70 | -17.80 | -17.20 | -17.20 | -17.00 | -17.20 | -17.90 | -18.00 | -17.70 | -17.70 |
| 72 | -20.70 | -19.10 | -17.80 | -18.10 | -17.80 | -3276.80 | -18.00 | -18.60 | -19.60 | -20.40 | -19.90 | -20.30 | -20.60 | -17.30 | -17.50 | -17.60 | -17.90 | -17.30 | -17.30 | -17.20 | -17.30 | -18.10 | -18.10 | -18.00 | -17.60 |

| Time (Hrs) | Chamber | | Mid-Tier | | Internal Walls | | | | Outer Walls | | | | | Tier 1 | | | | Tier 2 | | | | Tier 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chamber 1 | Chamber 2 | 1 | 2 | I-F2 | I-F4 | I-F5 | I-F6 | O-F2 | O-F3 | O-F4 | O-F5 | O-F6 | 3-5 | 4-2 | 5-6 | 6-4 | 7-5 | 8-2 | 9-6 | 10-4 | 11-5 | 12-2 | 13-6 | 14-4 |
| 73 | -21.10 | -19.10 | -18.00 | -18.10 | -17.90 | -3276.80 | -17.90 | -18.10 | -19.80 | -20.30 | -20.10 | -20.40 | -20.50 | -17.40 | -17.60 | -17.70 | -18.00 | -17.30 | -17.30 | -17.10 | -17.30 | -18.00 | -17.80 | -17.90 | -17.80 |
| 74 | -21.10 | -19.30 | -17.90 | -18.10 | -18.60 | -3276.80 | -17.90 | -18.10 | -19.70 | -20.30 | -20.10 | -20.40 | -20.40 | -17.50 | -17.60 | -17.80 | -17.80 | -17.20 | -17.10 | -17.20 | -17.20 | -18.10 | -18.10 | -18.20 | -18.10 |
| 75 | -20.90 | -19.30 | -18.00 | -18.20 | -17.70 | -3276.80 | -18.00 | -18.10 | -19.70 | -20.20 | -20.00 | -20.30 | -20.50 | -17.50 | -17.50 | -17.80 | -18.10 | -17.40 | -17.20 | -17.30 | -17.10 | -18.20 | -18.20 | -17.90 | -17.90 |
| 76 | -21.30 | -19.50 | -18.00 | -18.00 | -17.30 | -3276.80 | -18.20 | -18.90 | -19.80 | -20.20 | -20.10 | -20.30 | -20.40 | -17.20 | -17.70 | -17.80 | -18.10 | -17.50 | -17.30 | -17.30 | -17.30 | -17.80 | -17.90 | -17.90 | -17.80 |
| 77 | -21.40 | -19.30 | -17.90 | -18.10 | -17.30 | -3276.80 | -17.90 | -17.80 | -19.80 | -20.20 | -19.90 | -20.30 | -20.50 | -17.20 | -17.60 | -17.80 | -18.00 | -17.40 | -17.20 | -17.30 | -17.20 | -18.10 | -18.00 | -17.80 | -17.90 |
| 78 | -21.10 | -19.40 | -17.80 | -18.00 | -18.20 | -3276.80 | -19.00 | -18.10 | -19.90 | -20.10 | -20.20 | -20.40 | -20.60 | -17.40 | -17.50 | -17.80 | -17.80 | -17.00 | -17.00 | -17.00 | -17.10 | -17.90 | -18.00 | -18.00 | -18.10 |
| 79 | -21.00 | -19.40 | -17.90 | -18.00 | -17.70 | -3276.80 | -18.20 | -18.00 | -19.70 | -20.00 | -20.00 | -20.40 | -20.50 | -17.40 | -17.70 | -17.80 | -18.10 | -17.40 | -17.10 | -17.00 | -17.20 | -18.00 | -18.00 | -17.90 | -17.90 |
| 80 | -20.50 | -19.20 | -17.80 | -17.80 | -18.20 | -3276.80 | -18.30 | -17.70 | -19.60 | -19.90 | -20.00 | -20.50 | -20.70 | -17.40 | -17.40 | -17.70 | -17.90 | -17.10 | -17.10 | -17.10 | -17.20 | -18.10 | -18.10 | -18.00 | -18.10 |
| 81 | -15.40 | -17.70 | -17.90 | -17.90 | -17.90 | -3276.80 | -18.20 | -17.60 | -19.80 | -19.80 | -19.90 | -20.20 | -20.20 | -17.40 | -17.50 | -17.90 | -18.00 | -17.20 | -17.40 | -17.10 | -17.20 | -18.10 | -18.30 | -18.00 | -17.90 |
| 82 | -21.60 | -19.10 | -17.90 | -18.00 | -17.70 | -3276.80 | -17.60 | -17.50 | -19.60 | -20.10 | -19.90 | -20.30 | -20.20 | -17.10 | -17.30 | -17.70 | -17.80 | -17.30 | -17.20 | -17.20 | -17.30 | -18.00 | -18.10 | -17.80 | -17.70 |
| 83 | -21.50 | -19.20 | -17.80 | -18.10 | -17.60 | -3276.80 | -17.90 | -17.90 | -19.60 | -20.10 | -19.80 | -20.10 | -20.40 | -17.10 | -17.50 | -17.50 | -17.90 | -17.30 | -17.20 | -17.10 | -17.10 | -18.10 | -17.80 | -17.70 | -17.70 |
| 84 | -21.30 | -19.40 | -17.80 | -18.00 | -17.70 | -3276.80 | -17.60 | -17.90 | -19.70 | -20.10 | -20.00 | -20.10 | -20.40 | -17.40 | -17.60 | -17.80 | -17.90 | -17.20 | -17.20 | -17.10 | -17.10 | -17.90 | -18.10 | -17.80 | -17.60 |
| 85 | -20.90 | -19.10 | -17.90 | -17.90 | -18.10 | -3276.80 | -17.60 | -17.80 | -19.60 | -20.20 | -20.10 | -20.50 | -20.60 | -17.30 | -17.50 | -17.60 | -17.80 | -17.30 | -17.20 | -17.10 | -17.40 | -18.20 | -18.10 | -18.10 | -18.00 |
| 86 | -20.40 | -19.10 | -17.70 | -17.60 | -18.10 | -3276.80 | -18.40 | -18.60 | -19.70 | -19.80 | -20.00 | -20.30 | -20.50 | -17.10 | -17.20 | -17.50 | -17.60 | -16.90 | -17.00 | -16.90 | -16.90 | -17.70 | -17.70 | -17.70 | -17.60 |
| 87 | -20.80 | -19.20 | -17.70 | -17.70 | -18.20 | -3276.80 | -17.90 | -17.60 | -19.60 | -19.90 | -20.00 | -20.30 | -20.50 | -17.00 | -17.20 | -17.40 | -17.70 | -16.90 | -16.70 | -16.70 | -17.00 | -17.80 | -17.80 | -17.70 | -17.40 |

## 12.2. Composite IBC Data

Due to an unknown malfunction, channel I-F6 did not correctly measure the temperature values. As a result, data collected from this channel was not used for analysis.

| Time (Hrs) | Chamber | | Mid-Tier | | Internal Walls | | | | Outer Walls | | | | | Tier 1 | | | | Tier 2 | | | | Tier 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chamber 1 | Chamber 2 | 1 | 2 | I-F2 | I-F4 | I-F5 | I-F6 | O-F2 | O-F3 | O-F4 | O-F5 | O-F6 | 3-5 | 4-2 | 5-6 | 6-4 | 7-5 | 8-2 | 9-6 | 10-4 | 11-5 | 12-2 | 13-6 | 14-4 |
| 1 | -20.90 | -19.00 | -13.10 | -13.40 | -14.20 | -13.70 | -13.50 | -3276.80 | -16.90 | -17.00 | -16.40 | -16.30 | -16.40 | -10.70 | -11.50 | -11.70 | -11.80 | -12.80 | -12.50 | -13.10 | -12.80 | -13.80 | -13.60 | -13.60 | -13.50 |
| 2 | -20.90 | -19.40 | -13.40 | -13.60 | -14.80 | -14.50 | -13.90 | -172.10 | -17.30 | -17.80 | -16.80 | -16.60 | -16.70 | -11.30 | -11.80 | -12.20 | -12.30 | -13.00 | -12.60 | -13.00 | -12.80 | -13.90 | -14.00 | -13.90 | -13.90 |
| 3 | -21.00 | -19.50 | -13.40 | -13.70 | -15.00 | -14.90 | -13.70 | -166.10 | -17.30 | -18.10 | -16.70 | -16.60 | -16.80 | -11.80 | -12.30 | -12.60 | -12.70 | -13.10 | -12.80 | -13.20 | -12.90 | -14.50 | -14.40 | -14.20 | -14.20 |
| 4 | -20.20 | -19.20 | -13.50 | -13.90 | -14.80 | -14.10 | -13.60 | -182.80 | -17.40 | -18.10 | -17.00 | -16.70 | -16.90 | -12.10 | -12.50 | -12.90 | -13.20 | -13.30 | -13.10 | -13.30 | -13.00 | -14.60 | -14.50 | -14.50 | -14.30 |
| 5 | -20.50 | -19.30 | -13.50 | -14.10 | -12.80 | -14.50 | -13.80 | -145.90 | -17.50 | -18.30 | -17.00 | -16.80 | -17.00 | -12.60 | -12.90 | -13.10 | -13.30 | -13.50 | -13.00 | -13.30 | -12.90 | -14.60 | -14.70 | -14.50 | -14.60 |
| 6 | -21.50 | -19.60 | -13.70 | -14.40 | -15.30 | -15.70 | -14.60 | -67.50 | -17.70 | -19.00 | -17.20 | -16.90 | -17.00 | -12.90 | -13.20 | -13.50 | -13.50 | -13.60 | -13.60 | -13.80 | -13.30 | -15.10 | -15.10 | -15.00 | -15.00 |
| 7 | -21.00 | -19.50 | -13.80 | -14.60 | -15.10 | -15.20 | -14.40 | -103.70 | -17.80 | -19.00 | -17.30 | -17.00 | -17.30 | -12.90 | -13.10 | -13.60 | -13.60 | -13.60 | -13.30 | -13.80 | -13.30 | -15.20 | -15.20 | -15.20 | -15.00 |
| 8 | -21.40 | -19.40 | -14.00 | -14.70 | -15.70 | -15.60 | -14.60 | -88.00 | -17.90 | -19.00 | -17.30 | -16.80 | -17.30 | -13.10 | -13.30 | -13.70 | -14.00 | -13.80 | -13.60 | -13.90 | -13.70 | -15.40 | -15.40 | -15.30 | -15.40 |
| 9 | -19.80 | -18.50 | -14.20 | -14.60 | -14.70 | -15.00 | -14.50 | -129.50 | -17.20 | -19.10 | -17.10 | -17.30 | -17.30 | -13.20 | -13.60 | -13.90 | -14.00 | -13.80 | -13.80 | -13.90 | -13.50 | -15.40 | -15.40 | -15.30 | -15.30 |
| 10 | -21.00 | -19.60 | -14.30 | -14.70 | -15.90 | -15.40 | -14.70 | -78.40 | -17.90 | -19.10 | -17.80 | -17.40 | -17.50 | -13.30 | -13.60 | -13.90 | -14.00 | -14.20 | -13.80 | -14.30 | -13.90 | -15.60 | -15.70 | -15.40 | -15.30 |
| 11 | -20.80 | -19.30 | -14.40 | -15.00 | -16.00 | -16.00 | -15.00 | -1.30 | -18.10 | -19.10 | -17.90 | -17.50 | -17.50 | -13.30 | -13.80 | -14.00 | -14.10 | -14.30 | -14.00 | -14.30 | -13.90 | -15.80 | -15.70 | -15.60 | -15.50 |
| 12 | -21.10 | -19.50 | -14.50 | -15.00 | -16.40 | -16.10 | -15.00 | 32.50 | -18.20 | -19.80 | -18.00 | -17.70 | -17.80 | -13.40 | -13.80 | -14.20 | -14.30 | -14.40 | -14.20 | -14.50 | -14.10 | -15.90 | -16.00 | -15.60 | -15.90 |
| 13 | -21.30 | -19.60 | -14.60 | -15.30 | -15.80 | -15.90 | -15.40 | 50.60 | -18.60 | -19.90 | -18.20 | -17.90 | -18.20 | -13.60 | -14.00 | -14.30 | -14.40 | -14.50 | -14.10 | -14.40 | -14.30 | -15.90 | -16.00 | -15.80 | -15.80 |
| 14 | -20.70 | -19.70 | -14.90 | -15.30 | -15.90 | -15.90 | -15.30 | 82.20 | -18.40 | -19.10 | -18.20 | -18.00 | -18.10 | -13.40 | -14.10 | -14.50 | -14.80 | -14.70 | -14.50 | -14.70 | -14.50 | -16.30 | -16.20 | -16.00 | -16.00 |
| 15 | -20.90 | -19.60 | -15.10 | -15.50 | -16.70 | -16.70 | -15.80 | 40.50 | -18.60 | -19.90 | -18.30 | -17.90 | -18.10 | -13.90 | -14.20 | -14.60 | -14.80 | -14.70 | -14.50 | -14.70 | -14.50 | -16.30 | -16.30 | -16.20 | -16.10 |
| 16 | -21.30 | -19.60 | -15.10 | -15.80 | -16.10 | -15.60 | -15.70 | 11.40 | -18.50 | -19.60 | -18.20 | -18.10 | -18.20 | -14.10 | -14.40 | -14.80 | -14.90 | -14.90 | -14.70 | -14.90 | -14.70 | -16.40 | -16.40 | -16.30 | -16.10 |
| 17 | -21.20 | -19.70 | -15.20 | -15.70 | -15.90 | -15.70 | -15.40 | 4.50 | -18.70 | -19.80 | -18.30 | -18.30 | -18.50 | -14.30 | -14.50 | -15.00 | -15.20 | -15.00 | -14.90 | -15.00 | -14.70 | -16.60 | -16.50 | -16.30 | -16.10 |
| 18 | -20.80 | -19.50 | -15.30 | -15.90 | -16.60 | -16.30 | -16.10 | 26.00 | -18.60 | -19.60 | -18.40 | -18.10 | -18.50 | -14.50 | -14.70 | -15.00 | -15.20 | -15.10 | -14.90 | -15.10 | -14.80 | -16.50 | -16.50 | -16.50 | -16.50 |
| 19 | -21.30 | -19.50 | -15.40 | -16.00 | -16.90 | -16.70 | -16.10 | 29.40 | -18.90 | -20.00 | -18.50 | -18.40 | -18.70 | -14.50 | -14.70 | -15.00 | -15.30 | -15.10 | -15.10 | -15.10 | -15.00 | -16.70 | -16.90 | -16.80 | -16.50 |
| 20 | -20.70 | -19.40 | -15.50 | -16.00 | -16.40 | -15.60 | -15.80 | 27.10 | -18.80 | -19.60 | -18.70 | -18.60 | -18.70 | -14.60 | -14.70 | -15.20 | -15.40 | -15.30 | -15.10 | -15.20 | -15.10 | -16.60 | -16.70 | -16.70 | -16.60 |
| 21 | -21.30 | -19.50 | -15.60 | -16.00 | -16.70 | -16.10 | -16.00 | 70.90 | -18.80 | -19.80 | -18.60 | -18.40 | -18.60 | -14.60 | -14.80 | -15.10 | -15.30 | -15.20 | -15.10 | -15.40 | -15.10 | -16.60 | -16.90 | -16.60 | -16.60 |
| 22 | -20.90 | -19.60 | -15.90 | -16.10 | -16.70 | -17.00 | -16.10 | 58.20 | -19.00 | -20.10 | -18.60 | -18.60 | -18.60 | -14.70 | -15.10 | -15.40 | -15.60 | -15.50 | -15.40 | -15.50 | -15.50 | -17.10 | -17.10 | -16.90 | -16.90 |
| 23 | -21.10 | -19.50 | -15.80 | -16.30 | -16.60 | -16.80 | -16.20 | 84.50 | -18.90 | -20.00 | -18.70 | -18.70 | -18.80 | -14.80 | -15.10 | -15.50 | -15.60 | -15.40 | -15.20 | -15.40 | -15.40 | -17.20 | -17.00 | -16.70 | -16.60 |
| 24 | -21.10 | -19.50 | -15.90 | -16.30 | -16.40 | -16.70 | -16.20 | 114.60 | -18.90 | -19.70 | -18.80 | -18.80 | -18.70 | -14.80 | -15.20 | -15.60 | -15.80 | -15.50 | -15.40 | -15.70 | -15.40 | -17.00 | -17.20 | -17.00 | -17.00 |

| Time (Hrs) | Chamber | | Mid-Tier | | Internal Walls | | | | Outer Walls | | | | | Tier 1 | | | | Tier 2 | | | | Tier 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chamber 1 | Chamber 2 | 1 | 2 | I-F2 | I-F4 | I-F5 | I-F6 | O-F2 | O-F3 | O-F4 | O-F5 | O-F6 | 3-5 | 4-2 | 5-6 | 6-4 | 7-5 | 8-2 | 9-6 | 10-4 | 11-5 | 12-2 | 13-6 | 14-4 |
| 25 | -21.50 | -19.60 | -16.00 | -16.50 | -17.50 | -17.10 | -16.60 | 113.60 | -19.20 | -20.40 | -18.70 | -18.60 | -19.10 | -15.10 | -15.30 | -15.80 | -15.90 | -15.90 | -15.70 | -15.80 | -15.60 | -17.20 | -17.30 | -17.10 | -17.20 |
| 26 | -21.20 | -19.60 | -16.20 | -16.60 | -17.00 | -17.10 | -16.40 | 122.90 | -19.10 | -20.20 | -18.90 | -19.00 | -18.90 | -15.20 | -15.40 | -15.80 | -15.90 | -15.80 | -15.60 | -15.70 | -15.50 | -17.40 | -17.10 | -17.00 | -17.10 |
| 27 | -20.80 | -19.60 | -16.10 | -16.50 | -17.50 | -17.40 | -16.70 | 123.30 | -19.20 | -20.20 | -18.70 | -18.90 | -19.00 | -15.20 | -15.60 | -15.90 | -16.10 | -15.90 | -15.90 | -15.90 | -16.00 | -17.40 | -17.50 | -17.30 | -17.20 |
| 28 | -21.20 | -19.60 | -16.20 | -16.70 | -16.60 | -16.70 | -16.60 | 145.50 | -19.00 | -20.00 | -18.80 | -18.90 | -18.90 | -15.60 | -15.80 | -16.00 | -16.20 | -16.10 | -15.90 | -15.90 | -15.80 | -17.30 | -17.50 | -17.10 | -17.20 |
| 29 | -21.50 | -19.60 | -16.20 | -16.60 | -16.90 | -16.90 | -16.70 | 149.50 | -19.00 | -19.80 | -18.90 | -18.90 | -19.10 | -15.60 | -15.80 | -16.10 | -16.30 | -16.10 | -15.80 | -15.90 | -15.80 | -17.40 | -17.20 | -17.20 | -17.20 |
| 30 | -21.00 | -19.80 | -16.30 | -16.90 | -17.20 | -17.20 | -16.80 | 158.80 | -19.20 | -19.80 | -18.90 | -19.10 | -19.00 | -15.60 | -15.80 | -16.20 | -16.30 | -16.00 | -16.10 | -16.10 | -16.00 | -17.70 | -17.40 | -17.40 | -17.20 |
| 31 | -21.20 | -19.50 | -16.40 | -16.80 | -17.00 | -17.10 | -16.90 | 174.50 | -19.30 | -19.80 | -19.20 | -19.20 | -19.30 | -15.60 | -15.80 | -16.20 | -16.20 | -16.20 | -16.00 | -16.20 | -16.00 | -17.50 | -17.60 | -17.40 | -17.30 |
| 32 | -21.80 | -19.60 | -16.50 | -16.80 | -17.20 | -17.20 | -16.90 | 156.20 | -19.20 | -20.20 | -19.00 | -19.20 | -19.30 | -15.80 | -16.10 | -16.30 | -16.50 | -16.10 | -16.10 | -16.20 | -16.10 | -17.60 | -17.60 | -17.40 | -17.30 |
| 33 | -19.70 | -18.60 | -16.60 | -16.80 | -17.70 | -17.30 | -17.10 | 121.00 | -18.80 | -19.40 | -19.00 | -19.30 | -19.40 | -16.00 | -16.20 | -16.40 | -16.50 | -16.20 | -16.10 | -16.10 | -16.10 | -17.70 | -17.60 | -17.40 | -17.40 |
| 34 | -21.80 | -19.50 | -16.50 | -17.10 | -17.10 | -17.50 | -17.20 | 289.00 | -19.20 | -20.00 | -19.20 | -19.20 | -19.40 | -15.50 | -15.90 | -16.20 | -16.30 | -16.10 | -15.90 | -16.10 | -15.90 | -17.60 | -17.60 | -17.40 | -17.20 |
| 35 | -21.40 | -19.70 | -16.60 | -17.10 | -17.60 | -17.50 | -17.10 | -3276.80 | -19.50 | -20.00 | -19.30 | -19.50 | -19.70 | -15.40 | -15.90 | -16.40 | -16.40 | -16.20 | -16.10 | -16.30 | -16.00 | -17.50 | -17.60 | -17.40 | -17.30 |
| 36 | -20.60 | -19.50 | -16.60 | -17.10 | -17.20 | -16.80 | -17.10 | 376.40 | -19.40 | -19.50 | -19.30 | -19.60 | -19.50 | -15.50 | -16.10 | -16.40 | -16.60 | -16.50 | -16.20 | -16.40 | -16.10 | -17.50 | -17.70 | -17.30 | -17.40 |
| 37 | -20.60 | -19.50 | -16.70 | -17.20 | -17.70 | -17.60 | -17.10 | 380.70 | -19.70 | -20.10 | -19.40 | -19.60 | -19.80 | -15.70 | -16.30 | -16.50 | -16.60 | -16.40 | -16.20 | -16.30 | -16.20 | -17.60 | -17.60 | -17.50 | -17.40 |
| 38 | -21.10 | -19.70 | -16.50 | -17.00 | -17.70 | -17.20 | -17.20 | 362.00 | -19.60 | -20.20 | -19.40 | -19.60 | -19.80 | -15.70 | -16.20 | -16.50 | -16.70 | -16.40 | -16.40 | -16.50 | -16.40 | -17.70 | -17.80 | -17.40 | -17.40 |
| 39 | -20.30 | -19.60 | -16.80 | -17.00 | -17.50 | -17.50 | -17.10 | 328.80 | -19.50 | -19.70 | -19.40 | -19.80 | -19.80 | -15.80 | -16.30 | -16.70 | -16.80 | -16.50 | -16.30 | -16.40 | -16.20 | -17.70 | -17.40 | -17.40 | -17.40 |
| 40 | -21.20 | -19.70 | -16.90 | -17.30 | -18.10 | -17.60 | -17.30 | 276.30 | -19.80 | -20.40 | -19.60 | -19.70 | -19.90 | -16.00 | -16.30 | -16.70 | -16.70 | -16.50 | -16.20 | -16.50 | -16.50 | -17.70 | -17.70 | -17.50 | -17.50 |
| 41 | -21.60 | -19.70 | -16.90 | -17.20 | -17.40 | -16.90 | -17.00 | 260.90 | -19.60 | -20.30 | -19.50 | -19.70 | -19.60 | -16.10 | -16.40 | -16.70 | -16.90 | -16.60 | -16.50 | -16.60 | -16.40 | -18.00 | -17.70 | -17.60 | -17.50 |
| 42 | -20.90 | -19.60 | -16.90 | -17.30 | -18.00 | -17.50 | -17.70 | 277.40 | -19.60 | -20.30 | -19.60 | -19.60 | -20.00 | -16.20 | -16.50 | -16.70 | -17.00 | -16.60 | -16.50 | -16.50 | -16.50 | -17.90 | -17.80 | -17.60 | -17.70 |
| 43 | -20.40 | -19.80 | -17.20 | -17.20 | -18.50 | -18.40 | -17.60 | 285.70 | -19.80 | -20.30 | -19.80 | -20.00 | -20.20 | -16.20 | -16.50 | -16.70 | -16.90 | -16.50 | -16.50 | -16.70 | -16.40 | -17.80 | -17.90 | -17.70 | -17.60 |
| 44 | -21.10 | -19.60 | -17.10 | -17.30 | -17.30 | -17.20 | -17.40 | 243.90 | -19.60 | -20.00 | -19.40 | -19.70 | -19.90 | -16.40 | -16.70 | -16.90 | -17.00 | -16.60 | -16.50 | -16.70 | -16.60 | -17.70 | -17.80 | -17.60 | -17.50 |
| 45 | -21.10 | -19.80 | -17.10 | -17.30 | -18.30 | -17.70 | -17.50 | 248.60 | -19.80 | -20.20 | -19.50 | -19.80 | -19.90 | -16.40 | -16.70 | -17.00 | -17.30 | -16.80 | -16.80 | -16.80 | -16.80 | -17.90 | -18.10 | -17.80 | -17.70 |
| 46 | -20.60 | -19.70 | -17.10 | -17.60 | -17.60 | -17.50 | -17.60 | 242.10 | -19.90 | -20.30 | -19.90 | -20.00 | -20.30 | -16.40 | -16.70 | -17.10 | -17.20 | -16.90 | -16.70 | -16.90 | -16.80 | -18.10 | -17.90 | -17.80 | -17.70 |
| 47 | -21.00 | -19.60 | -17.10 | -17.40 | -17.30 | -17.20 | -17.60 | 257.40 | -19.60 | -20.10 | -19.50 | -19.80 | -19.80 | -16.40 | -16.80 | -17.10 | -17.30 | -16.90 | -17.00 | -16.80 | -16.80 | -18.00 | -17.80 | -17.80 | -17.60 |
| 48 | -20.30 | -19.30 | -17.30 | -17.60 | -18.00 | -18.00 | -17.80 | 271.30 | -19.70 | -20.10 | -19.70 | -19.90 | -20.30 | -16.50 | -16.80 | -17.10 | -17.30 | -16.90 | -16.60 | -16.70 | -16.70 | -17.90 | -17.80 | -17.70 | -17.70 |

| Time (Hrs) | Chamber | | Mid-Tier | | Internal Walls | | | | Outer Walls | | | | | Tier 1 | | | | Tier 2 | | | | Tier 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chamber 1 | Chamber 2 | 1 | 2 | I-F2 | I-F4 | I-F5 | I-F6 | O-F2 | O-F3 | O-F4 | O-F5 | O-F6 | 3-5 | 4-2 | 5-6 | 6-4 | 7-5 | 8-2 | 9-6 | 10-4 | 11-5 | 12-2 | 13-6 | 14-4 |
| 49 | -20.80 | -19.50 | -17.30 | -17.70 | -17.30 | -17.70 | -17.60 | 263.50 | -19.80 | -19.60 | -19.60 | -20.00 | -20.10 | -16.60 | -16.90 | -17.20 | -17.20 | -16.90 | -16.60 | -16.70 | -16.60 | -18.00 | -17.80 | -17.70 | -17.50 |
| 50 | -20.40 | -19.50 | -17.30 | -17.90 | -17.70 | -17.10 | -17.70 | 273.80 | -19.80 | -19.90 | -19.60 | -19.90 | -20.20 | -16.60 | -16.90 | -17.30 | -17.30 | -16.90 | -16.80 | -16.80 | -16.70 | -18.10 | -17.90 | -17.70 | -17.50 |
| 51 | -21.00 | -19.60 | -17.30 | -17.80 | -17.30 | -17.20 | -17.50 | 315.40 | -19.80 | -20.20 | -19.70 | -20.00 | -20.20 | -16.50 | -16.90 | -17.30 | -17.40 | -17.00 | -17.00 | -16.70 | -17.00 | -17.80 | -17.90 | -17.80 | -17.60 |
| 52 | -21.10 | -19.40 | -17.40 | -17.80 | -17.20 | -17.90 | -17.60 | 303.40 | -19.80 | -20.10 | -19.70 | -19.80 | -20.10 | -16.70 | -17.00 | -17.40 | -17.40 | -17.10 | -17.00 | -17.00 | -17.00 | -18.10 | -18.10 | -17.90 | -17.80 |
| 53 | -20.50 | -19.50 | -17.50 | -17.80 | -17.80 | -18.10 | -17.90 | 319.90 | -19.80 | -20.10 | -19.80 | -19.70 | -20.30 | -16.80 | -16.80 | -17.30 | -17.40 | -17.00 | -17.00 | -16.90 | -16.90 | -18.10 | -18.30 | -18.00 | -17.90 |
| 54 | -20.80 | -19.60 | -17.50 | -17.70 | -18.20 | -18.30 | -17.70 | 273.30 | -20.00 | -20.20 | -19.90 | -20.10 | -20.30 | -16.70 | -16.90 | -17.20 | -17.50 | -17.10 | -17.00 | -17.00 | -17.10 | -18.20 | -18.30 | -18.10 | -17.90 |
| 55 | -21.60 | -19.80 | -17.60 | -17.70 | -18.00 | -17.40 | -18.00 | 290.80 | -20.00 | -20.30 | -19.90 | -20.00 | -20.20 | -16.80 | -17.10 | -17.40 | -17.60 | -17.10 | -17.20 | -17.20 | -17.00 | -18.00 | -18.20 | -18.00 | -17.90 |
| 56 | -21.10 | -19.50 | -17.50 | -17.70 | -18.40 | -18.20 | -18.00 | 296.10 | -20.00 | -20.10 | -19.70 | -20.00 | -20.40 | -16.80 | -17.10 | -17.40 | -17.50 | -17.00 | -16.90 | -17.00 | -17.10 | -18.10 | -18.10 | -18.00 | -18.10 |
| 57 | -20.40 | -18.60 | -17.50 | -17.70 | -18.50 | -18.30 | -17.90 | 305.00 | -19.80 | -20.10 | -19.60 | -20.10 | -20.40 | -16.90 | -17.00 | -17.30 | -17.40 | -16.90 | -17.00 | -17.10 | -17.00 | -18.30 | -18.20 | -18.00 | -17.90 |
| 58 | -20.50 | -19.40 | -17.70 | -17.90 | -17.90 | -18.30 | -18.00 | -3276.80 | -19.80 | -19.60 | -19.60 | -20.30 | -20.20 | -15.90 | -17.00 | -17.40 | -17.50 | -17.00 | -16.90 | -16.90 | -16.70 | -18.10 | -18.10 | -18.00 | -17.90 |
| 59 | -21.00 | -19.70 | -17.30 | -17.70 | -17.30 | -17.30 | -18.10 | -3276.80 | -19.90 | -20.30 | -19.50 | -20.20 | -20.20 | -12.60 | -17.00 | -17.40 | -17.50 | -17.10 | -17.20 | -17.00 | -17.00 | -17.80 | -17.90 | -17.70 | -17.70 |
| 60 | -20.60 | -19.50 | -17.50 | -17.90 | -17.80 | -18.40 | -18.20 | -3276.80 | -19.80 | -19.70 | -19.70 | -20.00 | -20.40 | -15.50 | -17.00 | -17.40 | -17.60 | -17.00 | -16.80 | -16.70 | -16.70 | -17.90 | -18.00 | -17.70 | -17.70 |
| 61 | -21.60 | -19.50 | -17.40 | -17.90 | -17.50 | -17.20 | -17.80 | -3276.80 | -20.00 | -20.00 | -19.70 | -20.20 | -20.20 | -16.50 | -17.10 | -17.40 | -17.60 | -17.10 | -17.00 | -17.00 | -16.90 | -18.00 | -18.00 | -17.60 | -17.60 |
| 62 | -20.60 | -19.60 | -17.40 | -17.80 | -17.40 | -17.50 | -17.80 | -3276.80 | -19.90 | -20.20 | -19.80 | -20.00 | -20.20 | -16.60 | -17.20 | -17.30 | -17.60 | -17.30 | -17.20 | -17.00 | -17.00 | -17.90 | -17.90 | -17.80 | -17.60 |
| 63 | -20.70 | -19.60 | -17.50 | -17.90 | -17.90 | -18.00 | -17.90 | 391.70 | -20.00 | -19.90 | -19.90 | -20.20 | -20.50 | -16.60 | -17.10 | -17.50 | -17.50 | -17.00 | -16.90 | -16.90 | -16.90 | -17.90 | -18.00 | -17.80 | -17.70 |
| 64 | -20.70 | -19.50 | -17.40 | -17.60 | -18.00 | -17.60 | -17.60 | 378.30 | -19.90 | -20.10 | -19.90 | -20.20 | -20.40 | -16.70 | -17.00 | -17.50 | -17.50 | -17.10 | -17.00 | -17.00 | -17.10 | -18.00 | -18.00 | -17.90 | -17.80 |
| 65 | -21.20 | -19.60 | -17.50 | -18.00 | -17.80 | -18.00 | -18.10 | 358.20 | -19.90 | -19.80 | -19.80 | -20.10 | -20.30 | -16.80 | -17.10 | -17.60 | -17.70 | -17.30 | -17.00 | -17.10 | -16.90 | -18.00 | -18.10 | -17.80 | -17.80 |
| 66 | -20.70 | -19.50 | -17.50 | -18.00 | -18.00 | -17.90 | -17.90 | 370.70 | -19.80 | -20.20 | -19.80 | -20.10 | -20.30 | -16.80 | -17.20 | -17.50 | -17.70 | -17.10 | -17.00 | -16.90 | -17.00 | -18.00 | -18.00 | -17.80 | -18.00 |
| 67 | -20.60 | -19.60 | -17.40 | -17.90 | -18.20 | -17.80 | -17.80 | 361.70 | -19.90 | -20.40 | -19.90 | -20.30 | -20.40 | -16.70 | -17.10 | -17.50 | -17.60 | -17.00 | -16.90 | -17.00 | -17.00 | -18.30 | -18.10 | -18.00 | -17.90 |
| 68 | -20.70 | -19.70 | -17.60 | -17.50 | -18.80 | -18.40 | -17.80 | 334.30 | -20.20 | -20.30 | -20.10 | -20.30 | -20.50 | -16.90 | -17.20 | -17.50 | -17.50 | -17.20 | -17.00 | -17.00 | -17.20 | -18.10 | -18.10 | -18.00 | -18.00 |
| 69 | -20.90 | -19.70 | -17.60 | -17.60 | -17.90 | -18.00 | -18.00 | 326.40 | -20.30 | -20.80 | -20.00 | -20.30 | -20.50 | -17.00 | -17.20 | -17.60 | -17.70 | -17.20 | -17.00 | -17.20 | -17.20 | -18.10 | -18.00 | -18.00 | -17.90 |
| 70 | -20.50 | -19.50 | -17.50 | -17.90 | -17.70 | -17.70 | -17.80 | 329.70 | -20.10 | -20.40 | -19.80 | -20.40 | -20.40 | -16.90 | -17.20 | -17.60 | -17.80 | -17.30 | -16.90 | -17.30 | -17.10 | -18.20 | -18.00 | -17.90 | -17.80 |
| 71 | -20.30 | -19.60 | -17.60 | -17.90 | -17.50 | -17.90 | -18.00 | 322.60 | -19.90 | -19.90 | -20.00 | -20.30 | -20.60 | -17.00 | -17.30 | -17.60 | -17.70 | -17.30 | -17.10 | -17.20 | -17.10 | -18.00 | -18.00 | -17.90 | -17.90 |
| 72 | -20.50 | -19.70 | -17.80 | -18.00 | -18.00 | -18.00 | -18.20 | 317.90 | -20.10 | -19.90 | -20.00 | -20.30 | -20.60 | -17.00 | -17.20 | -17.60 | -17.60 | -17.20 | -17.10 | -17.20 | -17.10 | -18.10 | -17.80 | -18.10 | -17.70 |

| Time (Hrs) | Chamber | | Mid-Tier | | Internal Walls | | | | Outer Walls | | | | | Tier 1 | | | | Tier 2 | | | | Tier 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chamber 1 | Chamber 2 | 1 | 2 | I-F2 | I-F4 | I-F5 | I-F6 | O-F2 | O-F3 | O-F4 | O-F5 | O-F6 | 3-5 | 4-2 | 5-6 | 6-4 | 7-5 | 8-2 | 9-6 | 10-4 | 11-5 | 12-2 | 13-6 | 14-4 |
| 73 | -20.90 | -19.50 | -17.70 | -18.10 | -17.10 | -17.50 | -17.70 | 329.30 | -20.10 | -20.20 | -19.80 | -20.00 | -20.30 | -16.90 | -17.30 | -17.70 | -17.80 | -17.30 | -17.30 | -17.30 | -17.30 | -18.30 | -18.20 | -18.00 | -17.80 |
| 74 | -20.30 | -19.50 | -17.90 | -17.90 | -18.40 | -18.90 | -18.30 | 319.10 | -20.10 | -19.90 | -19.90 | -20.30 | -20.70 | -17.10 | -17.40 | -17.70 | -17.70 | -17.20 | -17.10 | -17.10 | -17.20 | -18.10 | -18.10 | -18.00 | -18.00 |
| 75 | -20.60 | -19.50 | -17.80 | -17.80 | -18.20 | -17.80 | -17.90 | 331.30 | -20.20 | -20.10 | -20.00 | -20.30 | -20.60 | -16.90 | -17.10 | -17.60 | -17.80 | -17.20 | -17.20 | -17.10 | -17.30 | -18.20 | -18.20 | -18.10 | -18.00 |
| 76 | -21.70 | -19.70 | -17.80 | -17.90 | -18.50 | -18.00 | -18.10 | 325.90 | -20.30 | -20.20 | -20.00 | -20.50 | -20.60 | -17.00 | -17.40 | -17.70 | -17.80 | -17.40 | -17.20 | -17.30 | -17.30 | -18.20 | -18.10 | -18.10 | -18.00 |
| 77 | -20.50 | -19.50 | -17.90 | -18.20 | -18.70 | -18.90 | -18.50 | 326.50 | -20.10 | -20.30 | -20.10 | -20.40 | -20.60 | -17.10 | -17.40 | -17.70 | -17.80 | -17.20 | -17.10 | -17.10 | -17.20 | -18.10 | -18.20 | -18.10 | -18.10 |
| 78 | -21.00 | -19.70 | -17.60 | -17.60 | -18.50 | -17.80 | -18.00 | 322.60 | -20.30 | -20.50 | -20.10 | -20.50 | -20.70 | -17.00 | -17.20 | -17.50 | -17.70 | -17.20 | -17.20 | -17.30 | -17.30 | -18.30 | -18.40 | -18.10 | -17.90 |
| 79 | -20.90 | -19.50 | -17.70 | -18.00 | -17.10 | -16.90 | -17.60 | 339.70 | -20.10 | -19.70 | -20.10 | -20.40 | -20.60 | -17.10 | -17.30 | -17.70 | -17.90 | -17.40 | -17.40 | -17.30 | -17.30 | -18.20 | -18.30 | -17.80 | -17.70 |
| 80 | -21.10 | -19.40 | -17.80 | -17.80 | -18.00 | -18.30 | -18.20 | 339.10 | -20.00 | -20.10 | -19.80 | -20.20 | -20.40 | -17.00 | -17.50 | -17.80 | -18.00 | -17.40 | -17.20 | -17.30 | -17.30 | -18.20 | -18.10 | -18.20 | -18.10 |
| 81 | -19.50 | -18.60 | -17.80 | -17.80 | -17.80 | -17.70 | -18.20 | 255.50 | -19.90 | -20.10 | -20.00 | -20.30 | -20.70 | -17.20 | -17.50 | -17.80 | -17.90 | -17.20 | -17.10 | -17.20 | -17.30 | -18.20 | -18.40 | -18.10 | -18.00 |
| 82 | -20.40 | -19.00 | -17.80 | -18.00 | -17.90 | -18.40 | -18.00 | -3276.80 | -19.70 | -19.30 | -19.70 | -20.30 | -20.50 | -15.10 | -17.20 | -17.70 | -17.80 | -17.30 | -17.20 | -17.10 | -17.40 | -18.20 | -18.10 | -18.10 | -18.10 |
| 83 | -21.20 | -19.50 | -17.90 | -18.20 | -17.50 | -17.10 | -17.60 | -3276.80 | -20.20 | -20.50 | -19.80 | -20.30 | -20.40 | -16.60 | -17.50 | -17.80 | -17.80 | -17.40 | -17.30 | -17.40 | -17.40 | -18.20 | -18.10 | -17.90 | -17.90 |
| 84 | -21.10 | -19.40 | -17.90 | -17.90 | -18.00 | -18.40 | -18.40 | -3276.80 | -19.80 | -19.60 | -19.80 | -20.30 | -20.50 | -16.80 | -17.40 | -17.80 | -17.90 | -17.20 | -17.10 | -17.10 | -17.10 | -17.90 | -17.90 | -17.70 | -17.90 |
| 85 | -21.40 | -19.70 | -17.70 | -18.10 | -18.70 | -18.90 | -18.10 | -3276.80 | -20.00 | -19.90 | -20.00 | -20.30 | -20.70 | -16.90 | -17.30 | -17.50 | -17.80 | -17.20 | -17.20 | -17.10 | -17.00 | -18.00 | -18.10 | -18.00 | -18.00 |
| 86 | -21.30 | -19.50 | -17.90 | -18.00 | -18.00 | -18.30 | -18.10 | -3276.80 | -20.00 | -20.00 | -19.80 | -20.40 | -20.50 | -17.00 | -17.50 | -17.80 | -17.90 | -17.40 | -17.40 | -17.20 | -17.20 | -18.10 | -18.00 | -17.90 | -17.80 |
| 87 | -21.00 | -19.40 | -17.80 | -18.00 | -17.50 | -17.90 | -18.10 | 393.50 | -20.00 | -20.40 | -19.80 | -20.30 | -20.10 | -17.00 | -17.60 | -17.80 | -17.90 | -17.30 | -17.20 | -17.10 | -17.20 | -17.90 | -17.80 | -17.80 | -17.70 |