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S. S. FREEDOM STRUCTURAL CHARACTERIZATION EXPERIMENT (SCE) NODE CODE

ROBERT L. JENSEN

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National Aeronautics and Space Administration

Langley Research Center
Hampton, Virginia 23665-5225

S.S. FREEDOM
STRUCTURAL CHARACTERIZATION EXPERIMENT (SCE)
NODE CODE

A presentation of a method of naming the Space Station Freedom nodes and truss members.

Prepared by the Langley Space Station Freedom Office
SE&I

By Robert L. Jensen

INTRODUCTION

The Space Station Freedom Program has developed a code system for naming the bays and faces of the space station for the purpose of identifying the location of elements, payloads and other equipment. For example, an external attached payload may be noted as being located at "SB4U", meaning it is located on the upper face of the fourth starboard bay.

However, at present, there is no way to expand that code system to describe other components of the Space Station Freedom. This document describes a method of expanding the Bay Code terminology to identify the nodes of the space station truss and the individual truss members and to allow for a consistent method for identifying elements of the evolutionary growth station.

JUSTIFICATION

A method of naming the truss nodes and members by a coding system would be very useful to the Space Station Freedom program. The location and documentation of the instrumentation and the routing of cables and wires could be described by the names of the nodes and/or truss members they are attached to. This would be of particular interest to programs like the Space Station Freedom Structural Characterization Experiment (SSFSCE) wherein instrumentation, such as accelerometers, will be utilized on the Freedom space station to characterize the structural dynamics of the station and to develop modeling technology for large space structures.

The Node Code could aid in describing the EVA construction sequences. Also, during EVA operations, the Astronaut could communicate his position relative to the space station by referencing the name of the nearest node.

During the maintenance and upkeep of the space station, records of the condition of the individual nodes and truss members could be maintained more efficiently if the parts had names. In fact, the naming of nodes and truss members would be beneficial to any type of record keeping required by the space station.

A Node Code would enhance communication within the Space Station Freedom program. The program would not only be able to describe the location of elements and other equipment by bay code, but now describe the applicable node connections and truss members.

In finite element modeling discussions, grid points are often used for reference. This is acceptable if the discussion is about a particular model produced by a particular organization where the grid points are unique. But, different models produced by different organizations will have dissimilar grid point designations. The Node Code can be used as a reference during discussions between the two model originators to assure that each modeler will be talking about the same location on the model.

Based on the above comments, it is apparent that the adoption of a Node Code has a distinct advantage to the S. S. Freedom program.

GROUND RULES FOR ESTABLISHING THE NODE CODE

Since the S.S. Freedom program has an existing bay and face coding system, any new coding system should be built from that terminology for consistency.

Any new coding system should be compatible with space station growth. The Node Code developed herein permits truss additions in all three coordinate system directions.

Since the alpha bays rotate, the coding system must be based on a fixed reference configuration. The reference configuration selected is at alpha = zero, as defined by the S.S. Reference Coordinate Systems Draft Document, JSC 30219, dated Jan. 4, 1989.

NODE CODE DESCRIPTION

Figure 1 is a copy of the Transverse Boom Space Allocation Preliminary Layout, Rev. "O", for the Space Station Freedom program. Though it is not the latest revision, it still can be used to show the current bay and face coding system used. The Freedom station consists of a transverse boom divided into eight starboard bays (SB) and seven port bays (PB), and starboard alpha (SA) and port alpha (PA) trusses with six bays each. Each bay has four faces. An Upper Face (U), Forward Face (F), Lower Face (L), and Aft Face (A). Using the letter codes with the number of the bay, each face of the truss bay can be named. For example, PB1F signifies the forward face of the first port bay, and SA6L denotes the lower face of the sixth starboard alpha bay.

Using the above Bay Code system as a baseline, the Node Code can be developed. To define the positions of the nodes of the space station, the y-axis is divided into zones at each bay interface. Directions along the z-axis are called elevations. Directions along the x-axis are called width. Then, each node can be defined by its zone, elevation and width position. But, there are only two elevation designations needed to locate a node in the "z" direction. The nodes are either at the Upper Face plane position or the Lower Face plane position of the space station. Similarly, there are only two width designations needed to locate the nodes in the "x" direction. The nodes are either at the Forward Face plane position or the Aft Face plane position.

Once nodes are identified by their zone, elevation and width position, a truss member can now be identified since it always lies between two nodes, say node 1 and node 2. But, to be consistent within the truss member identification so that each member has only one unambiguous identification, a rule has to be established to define which node is node 1. This is done by setting up a Datum Point located at a designated reference zone. Then, node 1 is defined as the node nearest to the Datum Point. If both nodes of a truss member are equidistant from the Datum Point, then the node nearest to the reference zone becomes node 1.

Figure 2 is a three dimensional illustration of the truss and shows the method of zone identification. The code for each bay is shown. Each interface between bays is denoted as a zone. The changeover from the starboard bays (SB) to the port bays (PB) is

selected as the reference zone and is named SBPB. The elevation and width can be established simultaneously by denoting the lower Forward Face line of the truss as LF, for Lower Forward. That is, the L signifies the lower elevation and the F signifies the forward width. Similarly, the upper Forward Face line is denoted as UF, for Upper Forward, where U signifies the upper elevation and F signifies the forward width. The lower Aft Face line is denoted as LA, for Lower Aft, where the L stands for the lower elevation and the A stands for the aft width, and the upper Aft Face line is denoted as UA, for Upper Aft, with the U denoting the upper elevation and the A denoting the aft width. Now the reference Datum Point can be selected and identified as being at zone SBPB, elevation L, and width F. This gives it a code name of (SBPB)(LF). No other node on the truss will have that name.

Additional zones are defined at the bay interfaces by radiating out from the Datum Point in either direction along the y-axis. In the port direction, the next bay interface is between PB1 and PB2 and therefore becomes zone 1PB2. The next bay interface lies between PB2 and PB3 and becomes zone 2PB3,and etc. At the Port Alpha Joint there is a transition from the transverse boom port bays (PB) to the port alpha bays (PA). This location is defined as zone PBPA. The last port bay of the Transverse Boom is PB7. Therefore, the zone at the bay interface between PB7 and the Port Alpha Joint transition truss (PB) is denoted as zone 7PBPB. The first bay of the Port Alpha truss is PA1. Therefore, the zone at the bay interface between the Alpha Joint transition truss (PA) and PA1 is denoted as PAPA1. Continuing out the Port Alpha truss, the bay interface between PA1 and PA2 is denoted as zone 1PA2. Between bay PA2 and bay PA3 the zone is 2PA3 and etc.

As can be seen in Figure 2, the same methodology is used to define the transverse boom starboard zones and the starboard alpha truss zones. The only difference is that they are located in the opposite direction from the Datum Point.

In Figure 2, each starboard node can be defined by its zone, elevation and width position. For example, (3SA2)(LF) is located on the lower Forward Face at zone 3SA2, elevation L and width F. Node (8SB7)(UA) is located on the upper Aft Face at zone 8SB7, elevation U and width A. Similarly, the port nodes can be defined. For example, node (6PB7)(UA) is located on the upper Aft Face at zone 6PB7, elevation U and width A.

It is apparent that the Reference Datum Point and the truss geometric center do not coincide since the port and starboard bay interface is not at the origin. This Node Code does not attempt to identify nodes by their coordinate system. Since each bay is a five meter cube and the coordinates of the Datum Point are $x = 2.5$, $y = -2.5$, and $z = 2.5$, coordinates could be assigned to each node if deemed necessary. But, the advantage

of this coding system is that it is more descriptive to list a node as being at (6PB7)(LF), than one that would list it as (2.5, -30.0, 2.5). The code name helps to provide a mental picture of the location of (6PB7)(LF) as being between the sixth and seventh port bays and at the lower face of the space station, wherein the numeric designation does not.

TRUSS MEMBERS

Once nodes are named, then truss members can be identified by their two node ends. Remember the rule that the node nearest the Datum Point, (SBPB)(LF). is node 1, or if the nodes are equidistant from the Datum Point, the node nearest the reference zone, SBPB, becomes node 1. Figure 3, a close up of the Port Alpha Joint, shows examples of truss member names. At zone 4PB5, a diagonal connects the lower Forward Face node to the Upper Aft Face node. Since the Lower Forward Face node is closest to the Datum Point, it becomes node 1. Therefore, the name of the truss member is [(4PB5)(LF)][(4PB5)(UA)]. Similarly, a diagonal on the Upper Face connects the Upper Aft node at zone 6PB7, to the Upper Face node at zone 7PBPB. Since the Upper Aft node at zone 6PB7 is nearest to the Datum Point, it becomes node 1. Therefore, the name of the truss member is [(6PB7)(UA)][(7PBPB)(UF)]. Other examples are shown in Figure 3.

In some cases, the truss member nodes are equidistant from the Datum Point. This occurs when starting out from the Datum Point at the reference zone. For example, referring back to Figure 2, the nodes of the diagonal truss members in PB1F and PB1U are equidistant from the Datum Point, (SBPB)(LF). For these cases the node nearest to the zone SBPB becomes node 1. Then the name for the diagonal of PB1F is [(SBPB)(UF)][(1PB2)(LF)], and the name of the diagonal for PB1U is [(SBPB)(UA)][(1PB2)(UF)].

SPECIAL PURPOSE CODES

Truss members for the Alpha Joint can also be named, but it requires setting up a new and different set of reference points to avoid confusion with the original selection. As shown in Figure 3, by taking a section of the Port Alpha Joint, the transition truss member connecting points can be identified by new code letters which are PT (Top) for the port top node, PR (Rear) for the port rear node, PD (Down) for the port bottom node, and PE (Eye Direction) for the forward node. Then, applying the right hand rule to the positive y-axis, the intermediate nodes become PTR, PRD, PDE, and PET.

Now the Alpha Joint truss members can be named. At zone 7PBPB, a diagonal connects the Upper Aft node to the PT node of the Alpha Joint at zone PBPA. Since the node at zone 7PBPB is nearest to the Datum Point, it becomes node 1. The name of this truss member is [(7PBPB)(UA)][(PBPA)(PT)]. At zone PBPA, a diagonal connects the intermediate Alpha Joint node PET to the Upper Face node at zone PAPA1. The node PET at zone PBPA is closest to the Datum Point. Therefore, this truss member is named [(PBPA)(PET)][(PAPA1)(UF)]. Similarly, the other truss members of the Alpha Joint can be named.

The same rationale is used for the Starboarb Alpha Joint, as shown in Figure 4, except that the letter "S" precedes the node identification. The nodes are ST, STR, SR, SRD, SD, SDE, SE, and SET respectively. At zone 1SASA, a diagonal connects the Upper Aft node to the ST node of the Alpha Joint at zone SASB. Since the node ST at zone SASB is nearest to the Datum Point, it becomes node 1. The name of the truss member is [(SASB)(ST)][(1SASA)(UA)]. At zone SASB, a diagonal connects the intermediate Alpha Joint node SET to the to the upper face node at zone SBSB8. The node at zone SBSB8 is nearest to the Datum Point so it is node 1. The name of the truss member is [(SBSB8)(UF)][(SASB)(SET)].

SPACE STATION GROWTH

One of the ground rules set up was that the Node Code must be compatible with space station growth. Presently, the last bay of the port alpha truss is PA6 as shown in Figure 2. Therefore, the last zone of the port alpha truss will be zone 6PA. For growth purposes, if a seventh bay was added, this zone would be renamed zone 6PA7, and the last zone would become 7PA. Similarly, the last bay of the starboard alpha truss is SA6. The last zone is denoted as SA6. If a seventh bay was added, this zone would be renamed 7SA6, and the last zone would become SA7.

The Transverse Boom is capable of growing in any direction along its coordinate axes. Figure 5 shows the method of naming the elevation and width for space station growth. As bays are extended from the Upper Face, the UF elevation becomes U1F, U2F and etc. The UA elevation becomes U1A, U2A and etc. Similarly, adding bays to the Lower Face, the elevations become L1F, L2F and L1A, L2A and etc. In the width direction, adding bays to the Aft Face becomes UA1, UA2 and LA1, LA2 and etc. Adding bays to the Forward Face they become UF1, UF2 and LF1, LF2 etc. Note that the numeric numbers are joined to the primary letter that denotes the face direction growth.

For example, in Figure 5, if two additional bays are extended from the Aft Face, the name of the upper batten in the last bay is [(SBPB)(UA2)][(1PB2)(UA2)]. If two bays

are extended from the Forward Face, the name of the upper diagonal in the last bay is [(4PB5)(UF1)][(5PB6)(UF2)]. Similarly, if two bays are extended from the upper face, the name of the aft longitudinal in zone 2PB3 in the second bay is [(2PB3)(U1A)][(2PB3)(U2A)].

Figure 6, illustrates the zone identification for the Freedom growth station. The zone notation still applies to the nodes along the y-axis even if they are not on the Transverse Boom. In the illustration shown, the nodes on the Lower Boom directly below the Datum Point are still at zone SBPB, 1PB2, 2PB3 and etc. Only the elevation has changed. The longitudinal member shown in Figure 6, is at elevation L7F and lies between nodes SBPB and 1PB2. Therefore, its name is [(SBPB)(L7F)][(1PB2)(L7F)]. Similarly, the longitudinal member shown on the Lower Port Keel at zone 4PB5, would be named [(4PB5)(L5F)][(4PB5)(L6F)]. Note that in each case that node 1 is the closest node to the Datum Point, (SBPB)(LF).

SUMMARY

The Node Code described herein is a useful method for the SSFSCE Project and the S.S. Freedom program to utilize for identifying nodes and truss members of the space station. Once one becomes familiar with the coding system, they can look at the code name of a node and/or a truss member and picture its location relative to other parts of the space station. It is compatible with the existing program code for identifying bays and truss faces and can be applied to the present configuration now and carried over to the growth phase later. The adoption of the code by the Space Station Freedom program would provide a tool that would enhance the present and future management, maintenance and record keeping methods utilized by the space station.

NOTES:
1 - THREE (3) SETS OF APAE TO BE SUPPLIED BY THE STATION, TBD APAE SETS TO BE SUPPLIED BY THE USER COMMUNITY.
2 - FOUR (4) UP* TO BE SUPPLIED BY THE STATION, TBD UP* TO BE SUPPLIED BY THE USER COMMUNITY.
3 - SOME GF'S ON MODULES, NODES, AND AIR LOCKS MAY BE CHANGED TO PG'S TO SATISFY KEEP ALIVE OR SAFE HAVEN REQUIREMENTS.
4 - APAE LOCATIONS FOR REFERENCE ONLY

LAST REVISION DATE & TIME	
K-	04/27/88 15:23
L-	05/18/88 13:00
M-	07/28/88 09:35
N-	09/14/88 13:00
O-	11/22/88 16:04

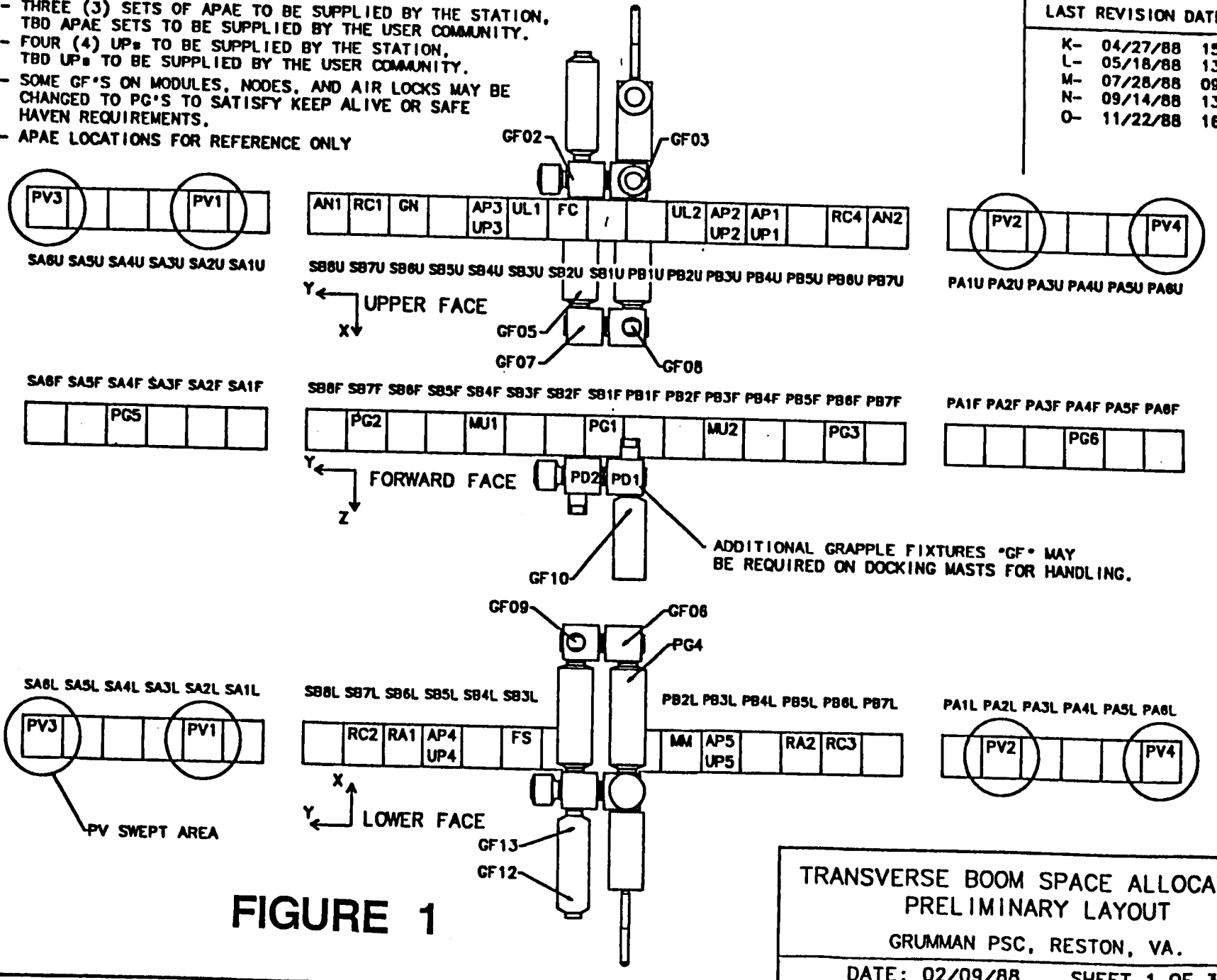
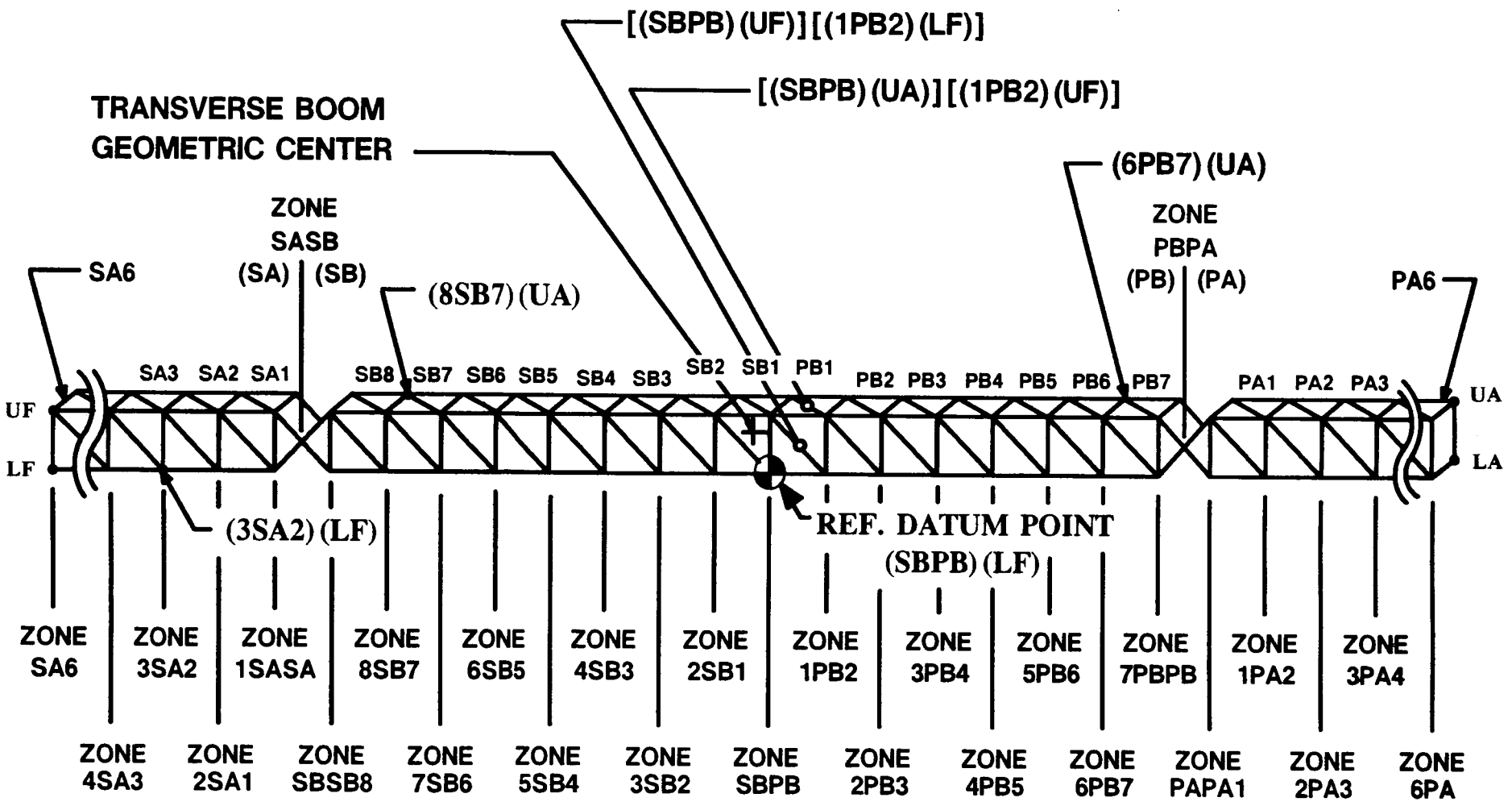


FIGURE 1

TRANSVERSE BOOM SPACE ALLOCATION
PRELIMINARY LAYOUT

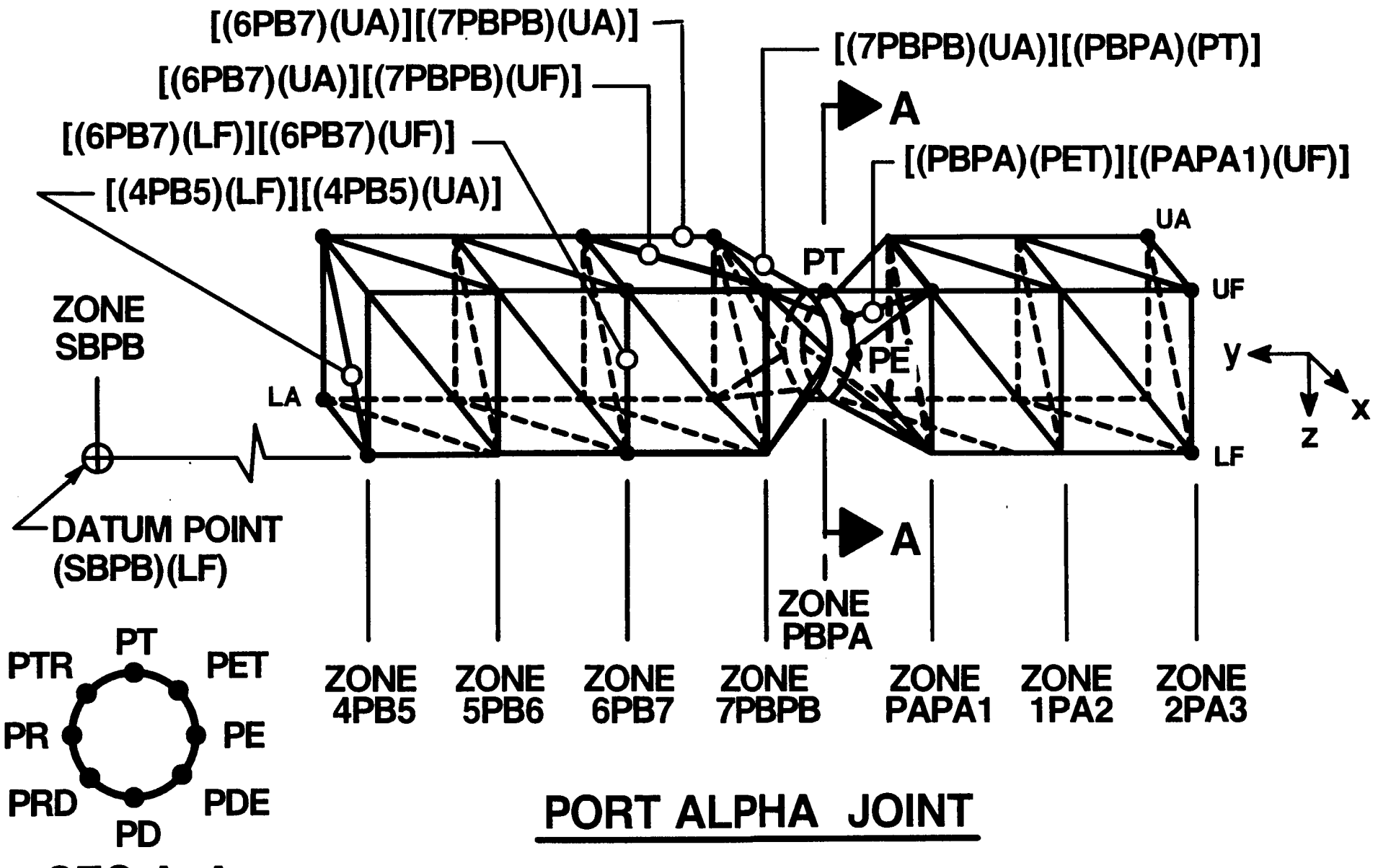
GRUMMAN PSC, RESTON, VA.

DATE: 02/09/88 SHEET 1 OF 3



ZONE IDENTIFICATION

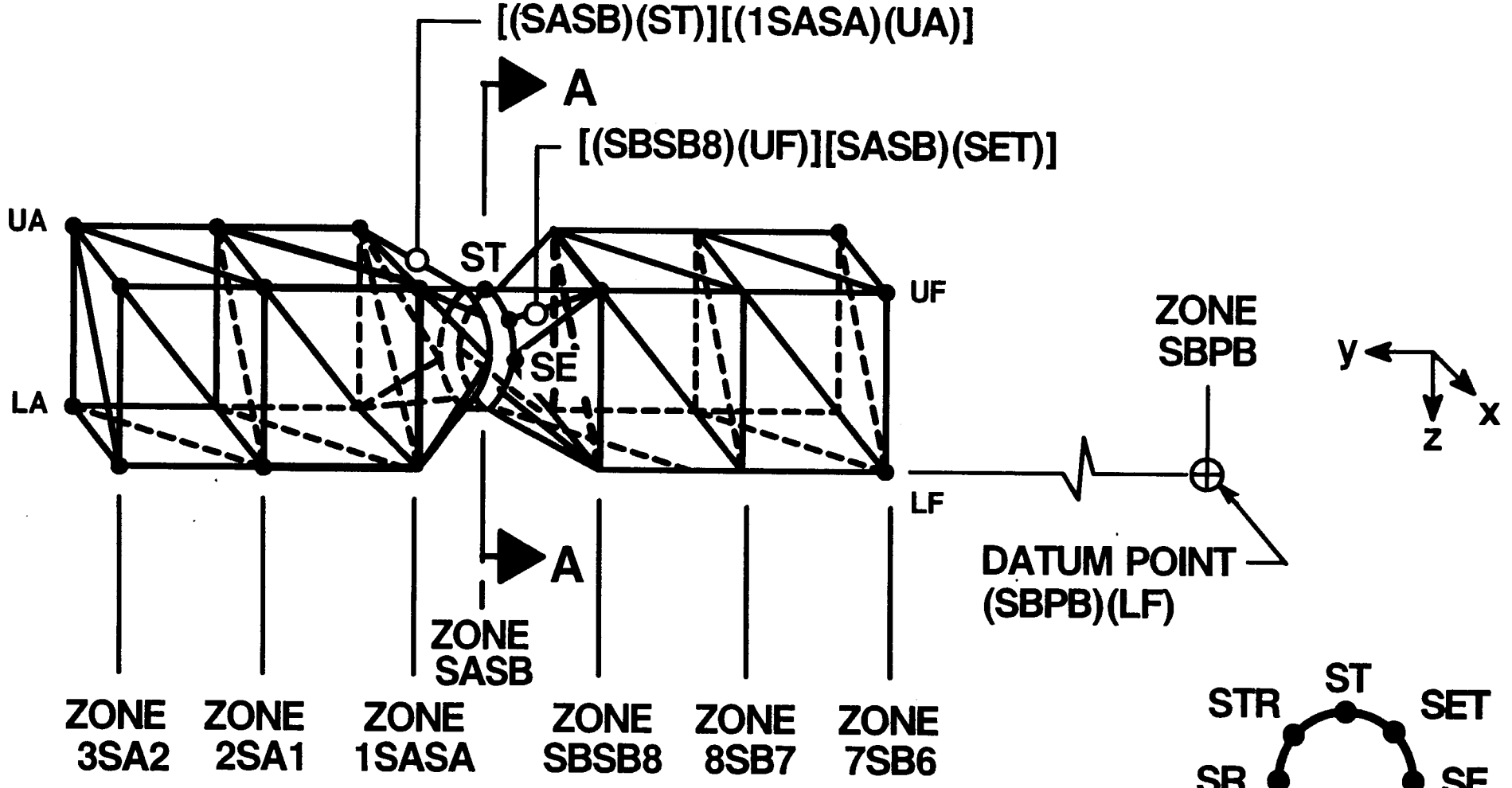
FIGURE 2



SEC A-A

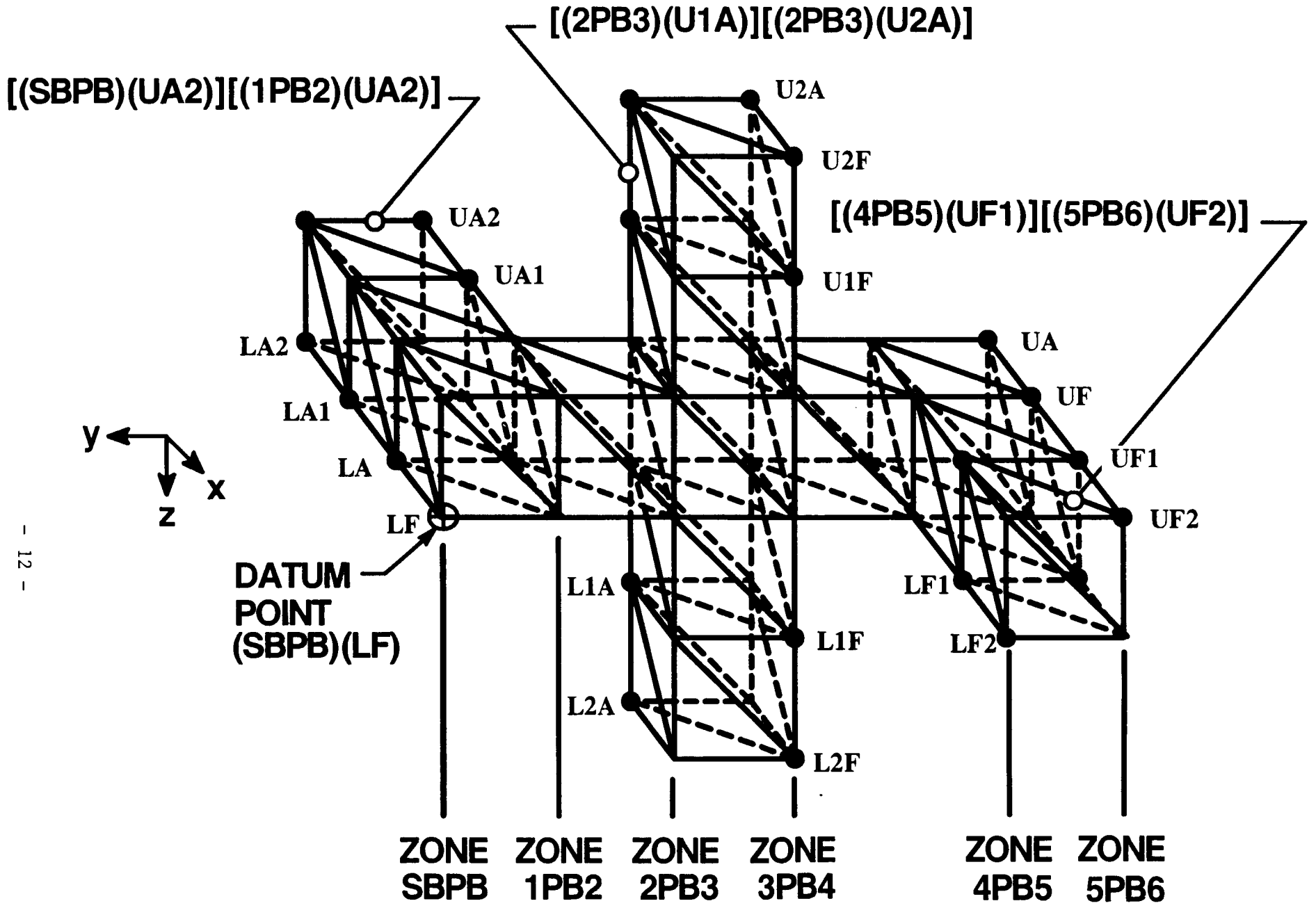
PORT ALPHA JOINT

FIGURE 3



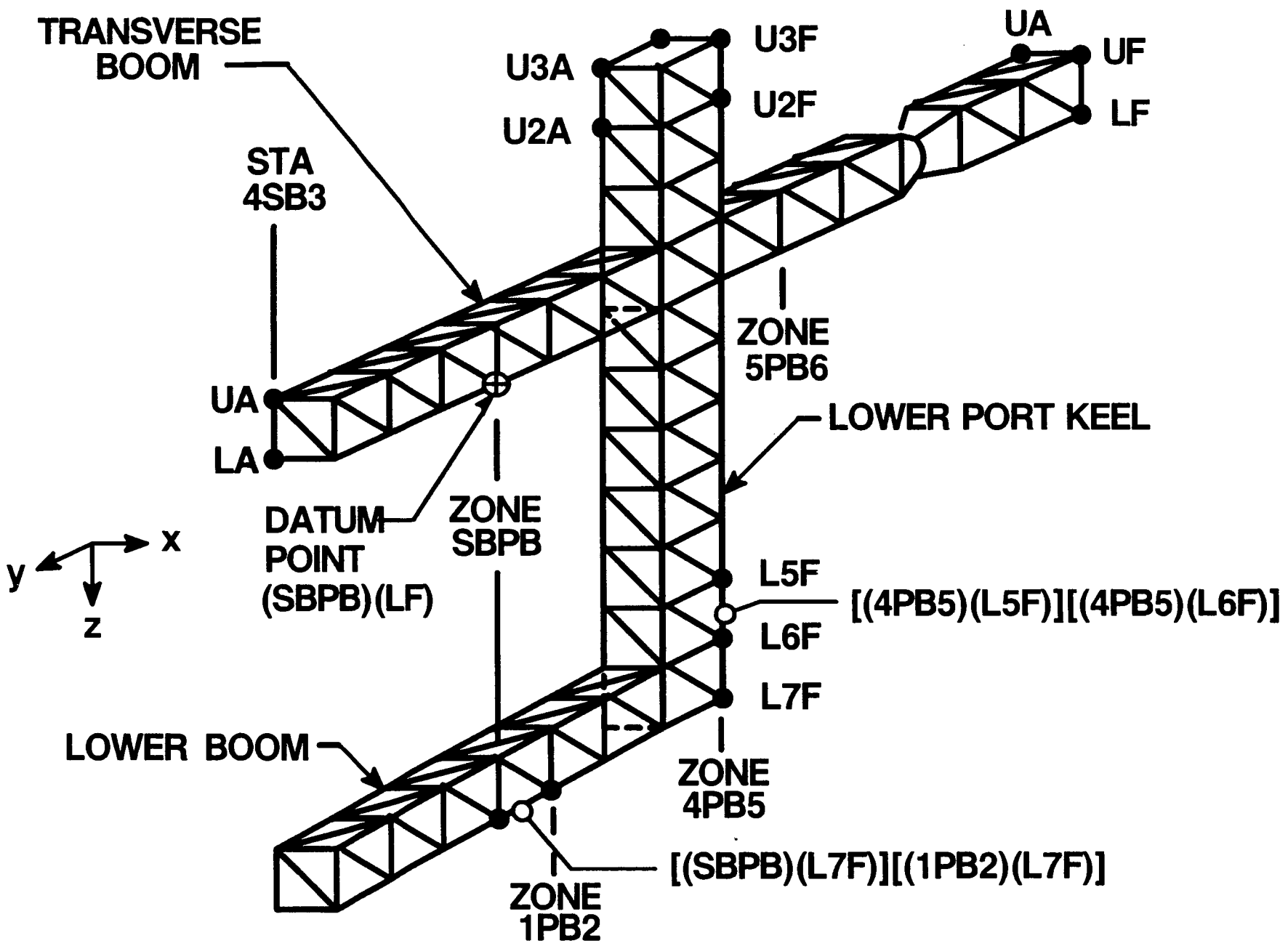
STARBOARD ALPHA JOINT

FIGURE 4



GROWTH PHASE

FIGURE 5



GROWTH PHASE CONT.

FIGURE 6

NASA National Aeronautics and Space Administration

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15. Supplementary Notes

16. Abstract

This document describes a method for naming the Space Station Freedom nodes and truss members that enhances the management, maintenance, and record keeping methods utilized by the space station.

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