5 CONCLUSIONS

The three-dimensional reflected surfaces of the rectangular valleys vary only slightly as the valley floor inclination is increased. The incident shock wave initially reflects off the wedge surface only as it starts advancing downstream. As the incident wave interacts with both the wedge and valley floor surfaces two prominent reflections occur. A primary reflected wave surface is generated from regular reflection off the wedge. This surface flows over into the valley contacting the incident wave at a second contact point. A secondary reflected wave is found underneath the primary reflected wave. This surface is generated due to the Mach reflection off the valley floor. The Mach reflection occurs across the entire width of valley floor. Near the valley wall the secondary reflected surface becomes slightly distorted as it climbs up the wall changing to regular reflection at the wedge surface. The second contact point of the primary reflected wave flows over into the valley travelling along a curved path until at a point is coincident with the triple point of the reflection off the valley floor. At this point the primary and secondary reflected wave surfaces are coincident. The area of the incident wave between the second contact point and the triple point is seen to bow out into the downstream flow. The Mach stem of the reflection off the valley floor tends to become less pronounced for the larger valley floor inclination angles. At forty-five degrees the Mach reflection is very close to the transition point of regular reflection. A sonic wave is generated at the first corner (bottom of the wedge) of the test piece which has increased influence on the flow as the incident wave advances downstream. In all the rectangular valleys, a shear layer is present. This shear layer effectively comprises of two different shear layers. One cascades down the valley wall and one develops along the valley entrance. These two shear layers merge to form the single shear layer at the corner of the valley entrance and the valley wall. The shear layer tends to decrease in size as the valley floor inclination increases. At a forty-five degree inclination the section of the shear layer at the valley entrance is almost non-existent. The presence of a second Mach reflection occurs in the x-y plane as the incident wave has advanced well into the valley. There is a double triple point with two Mach stems which are generated at the point where the primary and secondary reflected waves meet. Both prominent reflected surfaces are almost conical in nature at close proximity to the valley wall.

The triangular valleys show similar reflection patterns as the rectangular valleys. As the incident shock wave initially interacts with the wedge surface only regular reflection occurs. The resulting

reflected wave forms the primary reflected surface which flows over into the valley. The reflection changes to Mach reflection as the incident wave interacts with the valley floor. The Mach stem of the reflection off the valley floor increases in characteristic height as one moves from the valley entrance wall to the plane of symmetry. The characteristic height of the Mach stem is much smaller for the thirty and forty-five degree valley floor inclinations. A secondary reflected wave is found underneath the primary reflected surface. The secondary wave is Mach reflection near the plane of symmetry. As one moves further away the symmetry plane the reflection turns regular with the reflection point travelling across the width of the valley floor. Once the reflection point coincides with the valley entrance wall it begins to climb up and along the valley entrance wall where it finally coincides with the regular reflection at the wedge. The primary and secondary reflected surfaces merge near the plane of symmetry and again along the wedge surface. Corner signals from both the wedge corner and valley entrance point are generated at all valley floor inclinations. The signal generated at the valley entrance point decreases in strength as the valley inclination angle is increased. The slip stream resulting from the Mach reflection off the valley floor close to the plane of symmetry is most prominent at higher valley inclination angles. A shear layer is found to cascade down the valley entrance wall for all geometries, however, its strength decreases as the valley inclination angle increases.

The parabolic valleys show similar reflection patterns as the triangular valleys. As the incident wave initially interacts with the wedge surface only regular reflection occurs. As the incident wave advances further downstream and starts to interact with both the wedge and valley surfaces two reflected waves start to occur. The reflection off the wedge surface is regular. As the incident wave flows over into the valley the initial reflection off the valley floor, close to the valley entrance wall, is regular. This regular reflection then turns into Mach reflection off the valley floor the closer one moves to the symmetry plane. The Mach reflection off the valley floor forms a secondary reflected wave underneath the primary reflected wave that is found to flow over into the valley. The primary reflected wave contacts the incident wave at a second contact point found above the triple point. This contact point moves closer to the triple point as the incident wave advances downstream. The second contact point then moves along the secondary reflected wave as the incident shock advances even further. The second contact point at a single time instant is also seen to move closer to the triple point as one moves form the valley entrance wall to the plane of symmetry. A shear layer is found cascading down the valley entrance wall. The secondary reflected wave of the Mach reflection off the valley floor forms a semi-circular surface which contacts the floor just after the shear layer. The Mach reflection off the valley floor

changes to regular reflection as the surface begins to climb up along the valley entrance wall. The influence of the corner signal developed at the wedge corner is seen throughout the flow. The primary reflected surface flows over into the valley in a similar parabolic curvature to the valley.

The conical valleys once again show similar reflection patterns as those found in the other valley geometries. As the incident wave initially interacts with the wedge surface only regular reflection occurs. As the incident wave advances downstream, interacting with both the wedge and valley surfaces, two reflections now occur. Regular reflection occurs off the wedge surface with the resulting primary reflected wave flowing over into the valley. This primary reflected wave contacts the incident shock at a second contact point. The reflection off the valley floor is regular close to the valley entrance wall. As one moves closer to the plane of symmetry Mach reflection starts to occur off the valley floor. The reflected wave from the Mach reflection forms the secondary reflected surface. The secondary reflected surface is beneath the primary reflected wave. This secondary reflection, initially Mach reflection close to the symmetry plane, changes to regular reflection as one moves towards the valley entrance wall. When this transition has taken place the reflection point travels along the valley floor until coincident with the valley entrance wall, where it then travels along the valley entrance wall. The second contact point found on the incident wave from the primary reflected wave is found above the triple point. As one moves from the entrance wall to the plane of symmetry the second contact point moves down the incident shock to eventually coincide with the triple point. A weak shear layer is found to cascade down the valley entrance wall. A weak separation also occurs at the entry point of the valley.

The three hill geometries, triangular, parabolic and conical, all display similar reflection patterns. As the incident wave initially interacts with the wedge surface only regular reflection occurs. As the incident wave advances downstream regular reflection occurs off both the wedge and hill surfaces. The reflected waves come together at a point off the surface. At this point a double triple point occurs with two resulting Mach stems. One Mach stem contacts the wedge surface while the other contacts the hill surface. The resulting Mach stem surfaces wrap around the base of the hill in a lopsided upside down U shape (V shape for parabolic hill) which gets progressively tighter the closer it gets to the incident wave. The only major differences between all three geometries is the shape of the resulting reflected wave off the hill surface which tends to follow the same geometric shape as the hill and the distance between the two triple points for the conical and parabolic hills tends to be larger than that found for the triangular hill.