INVESTIGATION OF A CLAMSHELL ROLL-OUT EJECTION CONCEPT

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • NOVEMBER 1971
The equations for the motion, forces, and couples generated by clamshells released from spinning sounding rockets in accordance with a roll-out ejection concept are presented. The application of these equations to a study of a system for the Javelin (i.e., Honest John-Nike-Nike-X248) rocket vehicle is discussed.

The roll-out ejection concept advocated requires that each deploying clamshell be pivoted about an axis at its trailing edge located in the system sectioning plane. Clamshell despinning is a consequence of this deployment since the pivotal, i.e., roll-out, rate is in opposition to the rocket vehicle spin. The energy required by the deployment is derived largely from the rotational energy of the clamshell. Thus, the rocket vehicle will not be significantly despun by this kind of clamshell deployment.

This ejection concept also permits a system design which makes it possible to limit clamshell angular motion to rotation about that one of its centroidal principal axes which is brought into parallelism with the rocket vehicle longitudinal axis. Also, by equalizing the moments of inertia about the other centroidal principal axes, the roll-out motion can be decoupled from any extraneous angular motion about these axes.

Clamshells, Roll-Out, Nose Cone, Ejection, Sounding Rockets

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LIST OF SYMBOLS

$A, B, C, D =$ inertial parameters (slug-ft$^2$).

$C_{x_1}, C_{x_2}, C_{x_3} =$ hinge-couple components about axes parallel to the $x_1^-, x_2^-$, and $x_3^-$-axes, respectively (ft-lb).

$C_{y_1}, C_{y_2}, C_{y_3} =$ hinge-couple components about axes parallel to the clamshell body-fixed $y_1^-, y_2^-$, and $y_3^-$-axes, respectively (ft-lb).

$C\psi, C\theta, C\phi =$ cosines of the Euler angles $\psi, \theta, \phi$, respectively.

$d_1 =$ clamshell hinge-axis displacement from the $x_1$-axis (the rocket vehicle longitudinal axis) (ft).

$d_2 =$ clamshell center of mass (c.m.) displacement from the $x_1-x_2$-plane (the system bisection plane) before clamshell deployment (ft).

$d_3 =$ clamshell c.m. displacement from the system base plane (ft).

$d_5 =$ clamshell c.m. displacement from the hinge axis (ft).

$d_6 =$ clamshell c.m. displacement from the $x_2-x_3$-plane (the rocket vehicle system transverse plane containing its barycenter) (ft).

$d_7 =$ clamshell c.m. displacement from the $x_1$-axis during deployment (ft).

$d_{7f} =$ terminal value of $d_7$ (ft).

$F_{x_1}, F_{x_2}, F_{x_3} =$ hinge-force components directed along axes parallel to the $x_1^-, x_2^-$, and $x_3^-$-axes, respectively (lb).

$F_{y_1}, F_{y_2}, F_{y_3} =$ hinge-force components directed along axes parallel to the clamshell body-fixed $y_1^-, y_2^-$, and $y_3^-$-axes, respectively (lb).

$F_1, F_2, F_3, F_4, F_5 =$ inertial forces (lb).

$$J_{cy_1} = \int_m (y_2^2 + y_3^2) \, dm$$  \quad \text{significant elements of the clamshell inertia matrix defined in terms of the clamshell body-fixed $y$-frame (slug-ft$^2$).}$$

$$J_{cy_2} = \int_m (y_1^2 + y_3^2) \, dm$$
significant elements of the clamshell inertia matrix defined in terms of the clamshell body-fixed y-frame (slug-ft^2)

\[
J_{\text{cy}_3} = \int_m (y_1^2 + y_2^2) \, dm
\]

\[
J_{\text{cy}_5} = \int_m y_1 y_3 \, dm
\]

\[J_{\text{vx}_1}\] = rocket vehicle (minus-clamshells) spin moment of inertia (moment of inertia about the $x_1$-axis) (slug-ft^2).

\[J_{z_1}, J_{z_2}, J_{z_3}\] = clamshell moments of inertia about the $z_1^*$, $z_2^*$, and $z_3^*$-axes, respectively (slug-ft^2).

\[K\] = direction cosine matrix.

\[M_{\text{y}_1}, M_{\text{y}_2}, M_{\text{y}_3}\] = moments about the clamshell body-fixed $y_1^*$, $y_2^*$, and $y_3^*$-axes, respectively (ft-lb).

\[M_{z_1}, M_{z_2}, M_{z_3}\] = moments about the clamshell body-fixed $z_1^*$, $z_2^*$, and $z_3^*$-axes, respectively (ft-lb).

\[m\] = clamshell mass (slugs).

\[p\] = position vector from the origin of the $x$-frame to the clamshell c.m. (ft).

\[R_1\] = component of the position vector from an inertial frame origin to the $x$-frame origin directed along the rocket vehicle body-fixed $x_1$-axis (ft).

\[S\psi, S\theta, S\phi\] = sines of the Euler angles $\psi$, $\theta$, and $\phi$, respectively.

\[t\] = elapsed time (s).

\[t_f\] = time at the end of the clamshell deployment phase and the beginning of the free-flight phase (s).

\[U, V\] = momental parameters (ft-lb).

\[W_1, W_2, W_3\] = clamshell free-flight rotational rate components about the $z_1^*$, $z_2^*$, and $z_3^*$-axes, respectively ($s^{-1}$).

\[\{X_j\}\] = displacement vector for the $j$th point on the clamshell defined in terms of the $X$-frame (ft).

\[\{X_{\text{cm}}\}\] = clamshell c.m. displacement vector defined in terms of the inertial $X$-frame (ft).

\[\{z_j\}\] = displacement vector for the $j$th point on the clamshell defined in terms of the $x$-frame (the clamshell centroidal principal axis frame) (ft).

\[\alpha\] = angle between the $x_1 x_2$-plane and the plane defined by the $x_1$-axis and the position vector $p$.

\[\beta\] = angle in the clamshell mass-symmetry plane between the clamshell body-fixed $y$-frame and the clamshell centroidal principal axis set.
\( \gamma \) = clamshell roll-out angle (the angle between the \( x_1 x_2 \)-plane and the \( y_1 y_2 \)-plane).

\( \eta \) = angle between the \( x_1 x_2 \)-plane and the plane containing both the clamshell hinge axis and clamshell c.m.

\( \eta_0 \) = initial value of \( \eta \).

\( \alpha_f, \gamma_f, \eta_f \) = terminal values of \( \alpha, \gamma, \) and \( \eta \), respectively.

\( \psi, \theta, \phi \) = Euler angles (see Figure 6).

\( \Omega_1 \) = rocket vehicle spin (rotational rate of the x-frame) (s\(^{-1}\)).

\( \Omega_{1f} \) = terminal value of \( \Omega_1 \) (s\(^{-1}\)).

\( \Omega_{10} \) = initial value of \( \Omega_1 \) (s\(^{-1}\)).
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INTRODUCTION

In this report, a roll-out ejection concept for the release of clamshells from spinning sounding rockets is developed and discussed. The primary aim is to establish the desirability of this particular concept for use with sounding rockets. It will be seen that the conditions under which the clamshells are ejected impose requirements not considered in other applications. These requirements affect chiefly the manner in which the clamshells are to be ejected.

At the present time, there are two general categories of ejectable payload-protection devices. The conceptually older and structurally simpler of these devices is the one piece nose cone. A nose cone is essentially a shell of revolution with its aft end faired and attached to the top stage of the rocket vehicle. The cone is tapered to a closed fore end. The payload is situated in the space bounded by the nose cone and the rocket vehicle. The nose cone is impelled at its ejection by springs or other means in the direction in which the rocket vehicle is pointed. Obviously, this is not attempted while the rocket vehicle is thrusting—it must occur under coasting conditions. If the rocket vehicle has a control system, it may be maneuvered so that the ejected nose cone does not present a collision hazard during a subsequent thrust phase. Unfortunately, sounding rockets do not now have this maneuvering capability. Hence, the nose cone cannot be ejected safely until the sounding rocket is in its final coast phase and at an altitude where post ejection collision is not likely to occur. Thus, the performance of a sounding rocket can be impaired by its acceleration of excess mass. In the case of the Javelin (i.e., Honest John-Nike-Nike-X248) rocket vehicle, nose cone ejection is timed to occur 120 seconds after liftoff, when the vehicle is at an altitude of about 700,000 feet. At this point in the flight, any residual X248 thrust and the drag deceleration difference between the ejected nose cone and rocket vehicle are considered to be negligible. It will be seen that this particular nose cone ejection is set for a time which occurs significantly later than is possible with clamshells. It can be seen also that, in general, nose cone ejection is troublesome when the payload is long and impossible when the payload compartment is bulbous. Guides or bumpers running the length of the payload and ejection actuators with long strokes are required in the former instance to avoid nose cone hang up. The nose cone can still be a source of trouble after it has cleared the rocket vehicle. It effectively continues to precede the
payload in the trajectory and may affect instrument readings by emitting particles and disturbing the environment in other ways.

Clamshell systems are like nose cones, largely in overall shape. Each clamshell may be considered to be a longitudinal section of a shell of revolution. The clamshells are held together by bands, clamps, and the like, or they are attached to skin sections which can be ruptured at ejection time. On ejection, each clamshell is projected away from the longitudinal axis of the rocket vehicle; that is, its movement characteristically has a component which soon carries the clamshell out of the path of the payload. Therefore, the ejected clamshells do not continue to be collision hazards after they have cleared the rocket vehicle and payload. Thus, the time at which clamshell ejection is set to occur may be made meaningful in that it is not necessary to wait until the drag has dropped practically to zero before ejection. In fact, a slight amount of drag will help to increase the longitudinal separation between the payload and ejected clamshells. Obviously, the application of rocket vehicle thrust can produce even greater separation.

Ejection can occur for the Javelin when it is at an altitude of about 300,000 feet. At this point in its flight, it is about halfway into its X248 thrust phase. Perturbations due to X248 ignition and separation have been damped out, and the dynamic pressure has dropped to negligibly low values despite the considerable increase in vehicle velocity. The shape of the dynamic pressure profile for the Javelin is exemplified by the curve in Figure 1. The X248 thrust phase occurs between the tick marks located at 56 and 97.9 s. In addition to permitting the recording of scientific data at lower altitudes than it was possible previously, clamshell ejection even at this point in the final boost phase will have a significant effect on the performance of the Javelin. Because about two thirds of the vehicle velocity at final burnout is due to the X248 thrust phase, the release of clamshells earlier in the flight can improve the vehicle’s performance (see Figure 2).

Unfortunately, the conditions under which sounding rocket clamshells must operate have not been sufficiently considered in a number of designs. This situation may be partly due to the established success in the release of clamshells from nonspinning rocket vehicles, in which clamshells are disengaged and simply pitched out. It should be noted that in this case, the angular motion of each clamshell is restricted to rotation about that one of its centroidal principal axes normal to its mass symmetry plane. Hence, the motion of the clamshells during and after their deployment remains uncoupled and simple. This is not the case with clamshells pitched out from a spinning rocket vehicle. Instead, such an action causes each ejecting clamshell to rotate about all of its centroidal principal axes. The resulting complication greatly increases the extraneous tendencies of these clamshells and makes it difficult to design optimal constraints to control the clamshell motion during the deployment phase of ejection.

The extraneous tendencies should be reduced, if not eliminated, by essentially limiting clamshell angular motion to rotation about a single principal axis. This requires that each clamshell be rolled out since it is rolling to begin with. This can be done by pivoting it about an axis through either its leading or trailing edge in the clamshell system sectioning planes. Extraneous rotational tendencies may yet be induced in the clamshell by reaction to constraints utilized to develop the desired rolling motion. Thus, care must still be exercised in the design of roll-out clamshell ejection mechanisms.
Figure 1—Dynamic pressure profile for a Javelin launched at 80° QE (quadrant elevation angle) and carrying a 120-lb gross payload.

Figure 2—Effect of clamshell release time relative to X248 ignition on Javelin flight performance.
The angular momentum of a roll-out clamshell pivoted about its leading edge is increased on its deployment. This is caused by the displacement of its center of mass (c.m.) from the rocket vehicle longitudinal axis and the increase in its angular rate, which is a summation of its roll-out rate and the vehicular spin. The rocket vehicle will be despun by such clamshell deployment unless means are adopted to preclude it. This can be a troublesome endeavor since it tends to complicate the system design and increase its weight.

A clamshell pivoted about its trailing edge, on the other hand, is despun on its deployment since its pivotal, i.e., roll-out, rate is in opposition to the rocket vehicle spin. Thus, the energy for clamshell deployment can be expected to come initially from the rotational energy of the clamshell. The rocket vehicle will experience a measure of despinning after the clamshell has pivoted to a given roll-out angle. This will definitely be the case when the clamshell is totally despun, i.e., when the magnitude of the clamshell roll-out rate equals that of the rocket vehicle spin. The clamshell may be disengaged at this point in its deployment to give its free-flight motion a purely translatory character. However, in an actual flight, it may be preferable to release the clamshell earlier, i.e., at a smaller roll-out angle to reduce the extraneous torquing of the rocket vehicle during clamshell ejection. The selection of an optimum release angle is not obvious, particularly when too small an angle can result in a collision between the clamshells and the payload (this is the case with release at zero roll-out angle, i.e., instantaneous clamshell release). The effects of various system parameters must be investigated before any determination can be made with respect to this aspect or any other aspect of this problem.

ANALYTICAL ASSUMPTIONS

The following analysis is concerned with the equations for the motion, forces, and couples generated by clamshells released from spinning sounding rockets in accordance with a roll-out ejection concept. This concept requires that each ejecting clamshell be pivoted about an axis at its trailing edge in the system bisection plane so that its pivotal, i.e., roll-out, rate is in opposition to the rocket vehicle spin. Figure 3 illustrates the ejection sequence scheme viewed head-on to a rocket vehicle with a right-hand spin.

In order to facilitate resolution of the problem, it is assumed that there is a problem symmetry which permits the characterization of the system dynamics by those of a single clamshell. Thus, the

![Figure 3—Trailing edge pivot type of roll-out clamshell system with right-hand vehicle spin.](c)
clamshells are assumed to be dynamically matched, rigid bodies attached to a spinning rocket which is not coning in a significant manner when clamshell ejection is initiated. For convenience, it is assumed also that the damping and dissipative forces are negligible in comparison to the inertial forces.

Three coordinate frames are used in the analysis of the deployment phase dynamics. One of these is the $x$-frame, which is centered at the vehicle system barycenter and orientated so that its $x_1$-axis is coincident with the rocket vehicle longitudinal axis and its $x_2$-axis is directed in such a way that the clamshell system bisection plane is in the $x_1x_2$-plane. The $x$-frame may be assumed to be a rocket vehicle body-fixed frame since the barycenter may be considered to be stationary during the time required by clamshell deployment. The clamshell body-fixed $y$-frame is centered at the clamshell c.m. and orientated so that its $y_1$, $y_2$, and $y_3$-axes parallel the $x_1$, $x_2$, and $x_3$-axes, respectively, of the $x$-frame before clamshell ejection. The clamshell is constrained during its deployment to maintain the parallelism between the $x_1$ and $y_1$ axes. The $z$-frame is the clamshell centroidal principal axis set. It is oriented so that its $z_2$-axis is normal to the clamshell mass symmetry plane and coincident with the $y_2$-axis of the $y$-frame. The clamshell may be affixed with weights to rotate the $z_1$- and $z_3$-axes and bring them into alignment with the $y_1$- and $y_3$-axes, respectively, without changing the relationship between the $z_2$- and $y_2$-axes. When this is done, the $z$-frame and $y$-frame are identical. Figure 4 illustrates the spatial relationship between the $x$-, $y$-, and $z$-frames.

**EQUATIONS FOR THE SYSTEM ANGULAR MOTION**

The equations for the angular motions of the system, derived by an application of Lagrange's equation, may be written in a form suitable for digital computer solution as follows:

\[
\dot{\Omega}_1 = \frac{DU - BV}{AD - BC}
\]

and

\[
\ddot{\eta} = \frac{AV - CU}{AD - BC},
\]

where

\[
A = J_{yx_1} + 2(J_{cy_1} + md_2^2),
\]
\[
B = -2(J_{cy_1} + md_2^2) + 2md_5d_1 \cos \eta,
\]
\[
C = B,
\]
\[
D = 2(J_{cy_1} + md_2^2),
\]
\[
U = -2(2m\Omega_1 \dot{\eta}d_5 - m\eta^2d_5)d_1 \sin \eta,
\]
\[
V = 2m\Omega_1^2d_5d_1 \sin \eta,
\]

and

\[
AD - BC = 2J_{yx_1}(J_{cy_1} + md_2^2) + 4md_1^2[J_{cy_1} + md_5^2(1 - \cos^2 \eta)] \neq 0.
\]
EQUATIONS FOR THE HINGE FORCES

The hinge-force components are obtained by the application of Newton’s Second Law to the acceleration of the clamshell c.m. This yields

\[ F_{x_1} = m\ddot{R}_1, \]

\[ F_{x_2} = F_1 \sin \eta + (F_2 - F_3) \cos \eta - F_4 \sin \alpha - F_5 \cos \alpha, \]

and

\[ F_{x_3} = F_1 \cos \eta - (F_2 - F_3) \sin \eta + F_4 \cos \alpha - F_5 \sin \alpha, \]

where

\[ F_1 = m\ddot{\eta}d_5, \]
\[ F_2 = m\ddot{\eta}^2 d_5, \]
\[ F_3 = 2m\dot{\Omega}_1 \dot{\eta}d_5, \]
\[ F_4 = m\dot{\Omega}_1 d_7, \]

and

\[ F_5 = m\Omega_1^2 d_7. \]

EQUATIONS FOR THE HINGE COUPLES

From Figures 4 and 5, it can be shown that

\[ C_{x_1} = C_{y_1}, \]
\[ C_{x_2} = C_{y_2} \cos \gamma + C_{y_3} \sin \gamma, \]
\[ C_{x_3} = C_{y_3} \cos \gamma - C_{y_2} \sin \gamma, \]
\[ F_{y_1} = F_{x_1}, \]
\[ F_{y_2} = F_{x_2} \cos \gamma - F_{x_3} \sin \gamma, \]

and

\[ F_{y_3} = F_{x_3} \cos \gamma + F_{x_2} \sin \gamma, \]

where

\[ C_{y_1} = M_{y_1} - F_{y_2} d_2 - F_{y_3} d_1, \]
\[ C_{y_2} = M_{y_2} + F_{y_1} d_2 - F_{y_3} d_3, \]
\[ C_{y_3} = M_{y_3} + F_{y_1} d_1 + F_{y_2} d_3, \]
\[ M_{y_1} = M_{z_1} \cos \beta - M_{z_3} \sin \beta, \]
\[ M_{y_2} = M_{z_2}, \]

and

\[ M_{y_3} = M_{z_3} \cos \beta + M_{z_1} \sin \beta. \]
Solution of the preceding equations requires the application of Euler's equation of motion to the problem; thus,

\[ M_{z1} = J_{z1} (\dot{\Omega}_1 - \dot{\eta}) \cos \beta , \]
\[ M_{z2} = (J_{z2} - J_{zl})(\Omega_1 - \dot{\eta})^2 \cos \beta \sin \beta , \]
and
\[ M_{z3} = -J_{z3} (\dot{\Omega}_1 - \dot{\eta}) \sin \beta , \]

where

\[ J_{z1} = J_{cy_1} \cos^2 \beta + J_{cy_3} \sin^2 \beta \]
\[ - 2J_{cy_3} \cos \beta \sin \beta , \]
\[ J_{z2} = J_{cy_2} , \]
and
\[ J_{z3} = J_{cy_1} \sin^2 \beta + J_{cy_3} \cos^2 \beta \]
\[ + 2J_{cy_3} \cos \beta \sin \beta . \]

**EQUATIONS FOR FREE FLIGHT**

The free-flight displacements of the jth point on the clamshell may be expressed in terms of the X-frame, an inertial frame which is orientated so that its \(X_1^*, X_2^*,\) and \(X_3^*\)-axes parallel the \(x_1^*, x_2^*,\) and \(x_3^*\)-axes of the x-frame at the instant of clamshell disengagement. This inertial frame translates at the rate established by the rocket vehicle at this time; thus,

\[ \{X_j\} = K\{z_j\} + \{X_{c.m.}\} , \]

where

\[ K = \begin{bmatrix} C\theta \ C\phi & -S\theta & C\theta \ S\phi \\ C\psi \ S\theta \ C\phi + S\psi \ S\phi & C\psi \ C\theta & C\psi \ S\theta \ S\phi - S\psi \ C\phi \\ S\psi \ S\theta \ C\phi - C\psi \ S\phi & S\psi \ C\theta & S\psi \ S\theta \ S\phi + C\psi \ C\phi \end{bmatrix} \]

and

\[ \{X_{c.m.}\} = (t - t_f) \begin{bmatrix} \dot{\eta}_f d_5 \sin \eta_f - \Omega_{1f} d_{7f} \sin \alpha_f \\ \dot{\eta}_f d_5 \cos \eta_f + \Omega_{1f} d_{7f} \cos \alpha_f \end{bmatrix} + \begin{bmatrix} d_6 \\ d_{7f} \cos \alpha_f \\ d_{7f} \sin \alpha_f \end{bmatrix} . \]

The square \(K\)-matrix is a direction cosine matrix based on the Euler angle system shown in Figure 6. This angular system is a variant of a system used widely by aeronautical engineers. It is utilized to
simplify the determination of the initial Euler angles. From the construction in Figure 6, it can be shown that

\[
\dot{\psi} = \frac{W_3 \sin \phi + W_1 \cos \phi}{\cos \theta},
\]

\[
\dot{\theta} = W_3 \cos \phi - W_1 \sin \phi,
\]

\[
\dot{\phi} = W_2' + \dot{\psi} \sin \theta,
\]

\[
\psi = \int_t^\tau \dot{\psi} \, dt - \gamma_f,
\]

\[
\theta = \int_t^\tau \dot{\theta} \, dt,
\]

and

\[
\phi = \int_t^\tau \dot{\phi} \, dt - \beta.
\]

The z-frame components of the clamshell rotational rate may be obtained from Euler’s equations of motion for the free flight; thus,
\[ \dot{W}_1 = \frac{W_2 W_3 (J_{z_2} - J_{z_3})}{J_{z_1}} , \]
\[ \dot{W}_2 = \frac{W_3 W_1 (J_{z_3} - J_{z_1})}{J_{z_2}} , \]
\[ \dot{W}_3 = \frac{W_1 W_2 (J_{z_1} - J_{z_2})}{J_{z_3}} , \]
\[ W_1 = \int \dot{W}_1 \, dt + (\Omega_{1f} - \eta_f) \cos \beta , \]
\[ W_2 = \int \dot{W}_2 \, dt , \]
and
\[ W_3 = \int \dot{W}_3 \, dt - (\Omega_{1f} - \eta_f) \sin \beta . \]

**DISCUSSION**

Figures 7 through 25 illustrate the results of a study of a roll-out clamshell system for the Javelin rocket vehicle. The digital computer program and a data deck utilized in this study are listed in Appendix A. Nominal system data, if the use of unaligned clamshells for which the \( \beta \)-angle is not zero is assumed, are estimated to be as follows:

\[ J_{ex_1} = 7.5 \text{ slug-ft}^2 , \]
\[ m = 0.4 \text{ slug} , \]
\[ J_{cy_1} = 0.1178 \text{ slug-ft}^2 , \]
\[ J_{cy_2} = 0.3466 \text{ slug-ft}^2 , \]
\[ J_{cy_3} = 0.4200 \text{ slug-ft}^2 , \]
\[ J_{cy_5} = 0.03219 \text{ slug-ft}^2 , \]
\[ d_1 = 0.8042 \text{ ft}^2 , \]
\[ d_2 = 0.4286 \text{ ft}^2 , \]
\[ d_3 = 1.456 \text{ ft}^2 , \]
\[ \Omega_{10} = 9.5 \text{ rev/s} , \]
\[ \ddot{R}_1 = 515 \text{ ft-s}^{-2} . \]
When the study is applied to aligned clamshells, i.e., clamshells wherein the $\beta$-angle has been zeroed, the applicable clamshell parameters are changed as follows:

\[
\begin{align*}
    m &= 0.4592 \text{ slug}, \\
    J_{cy_1} &= 0.1656 \text{ slug-ft}^2, \\
    J_{cy_2} &= 0.4654 \text{ slug-ft}^2, \\
    J_{cy_3} &= 0.5676 \text{ slug-ft}^2, \\
    J_{cy_5} &= 0.0 \text{ slug-ft}^2, \\
    d_2 &= 0.3733 \text{ ft}, \\
    d_3 &= 1.268 \text{ ft}.
\end{align*}
\]

These changes reflect the effects of alignment brought about by the attachment of two weights to each clamshell in a manner which results in minimum clamshell mass increase.

The system motion and the hinge forces and couples generated by clamshell deployment are shown in Figures 7 through 10. There appears to be no significant difference between systems using unaligned and aligned clamshells according to these figures.

It should be noted that the rocket vehicle is subject to slight spin-up followed by negligible despinning as the clamshells deploy. The individual and the total effects are of the order of a percent of the initial vehicular spin over the range of roll-out angles considered. No violation of angular momentum conservation is represented by the rocket vehicle spin-up because each clamshell is being despun as it rolls out. The vehicular spin-up signifies that the energy taken from the rotation of the clamshells is more than sufficient for their deployment. The excess energy is not large, so the spin-up is not significant. This observation applies also to the energy deficit which results in the rocket vehicle despinning at the larger roll-out angles. Thus, no special rocket vehicle despin avoidance devices are needed for the clamshell system simulated.

Reversing the rocket vehicle spin permitted a comparative study of a roll-out system with pivot axis at the clamshell leading edge. As expected, such a system subjects the rocket vehicle to greater despinning and generates hinge forces and couples of considerably larger magnitudes than the system with trailing edge pivot. These effects, illustrated in Figures 11 and 12, are attributed to the fact that the clamshells are spun up as they roll out. It will be seen that this spin-up also raises the minimum roll-out angle at which the clamshells can be safely disengaged. Thus, a roll-out system with pivot axis located at the clamshell trailing edge is preferable to a system with pivot axis at the leading edge.

It may be inferred from Figures 8 and 10 that the hinge couples are more significant to the system designer than the hinge forces. Thus, Figures 13 through 16 are included to illustrate the effects of rocket vehicle spin and longitudinal acceleration on $C_{x_2}$ and $C_{x_3}$, the hinge couples which oppose the clamshell pitching and yawing tendencies, respectively. As expected, the rocket vehicle spin at the higher levels investigated produces a decidedly bad effect on $C_{x_2}$ and $C_{x_3}$. On the other hand, the rocket
vehicle longitudinal acceleration tends to reduce the maximum magnitude of $C_{x_3}$ by shifting its time trace upward. No such beneficial effect is incurred for $C_{x_2}$ despite a similar upward shifting of its time trace. Whatever the case may be, the magnitudes of $C_{x_2}$ and $C_{x_3}$ indicate that serious consideration should be given to reducing the rocket vehicle spin to about a half of that presently utilized. Use of a lower rocket vehicle spin can improve the X248 motor performance in addition to moderating the design requirements of the clamshell system.

The $X_2X_3$ projections of the near free-flight displacements of clamshells released at roll-out angles of 12.5, 15, 30, and 60 deg are shown in Figures 17 through 23. Except in Figure 19, these projections are for aligned clamshells. Since the $X_1X_2$ and $X_1X_3$ projections for these clamshells are straight lines, and therefore of little interest, they are not presented. Figure 19 shows that the near free-flight displacements of an unaligned clamshell under the conditions considered is not markedly different from that of an aligned clamshell. It is possible that conditions beyond the scope of this study could produce effects requiring further investigation.

Figures 17 and 20 show that roll-out clamshells can be released too soon. In each case, the clamshell rotational magnitude is too high for release at the roll-out angle shown. Obviously, clamshell release can take place safely at a lower roll-out angle with the trailing edge pivot type of system because the clamshells are subject to despinning and the offending parts are displaced farther away from the payload when disengagement occurs. The rotation of each clamshell will be near zero, and its free-flight motion thereby will be almost purely translatory when the clamshell is released at a roll-out angle of 60 deg. This effect occurs near 60 deg for the system under consideration at the various vehicle spin rates shown in Figure 24. Indeed, the angular motion of the system can be characterized by the reduced forms contained in Figure 25. This figure shows that the relationship between $\Omega_1$ and $\dot{\gamma}$ is constant for any given roll-out angle. The locus of points in $X$-space through which a given part of the clamshell passes is fixed therefore by the $\gamma$-angle at which disengagement occurs. The vehicular spin merely affects the rate at which such a given set of points in $X$-space is traversed. Thus, clamshells which can be released safely at 15 deg when vehicular spin is 9.5 rev/s can also be released safely at this angle at any other positive vehicular spin if the system can bear the loads imposed upon it. That is, clamshell release for the system under consideration can be programmed for roll-out angles between 15 and 60 deg. Choice of the lower angles will be influenced by the desire to reduce unbalanced torquing of the rocket vehicle during clamshell deployment. This torquing may arise from vehicular coning motion, clamshell mismatch, and the “yo-effect” caused by nonsimultaneous release of clamshells. On the other hand, release at a higher roll-out angle is desirable because it results in the ejection of clamshells with reduced rotational motion and lowered likelihood of collision with the payload.

The system angular motions are not affected by the rocket vehicle longitudinal acceleration. The system characteristics discussed in the preceding paragraph will therefore be independent of deviations in rocket vehicle thrust. Since the various acceleration levels are normally associated with different system mass properties, it was expected that the curves in the figures discussed would reflect this fact. This mass effect, however, tends to be a minor one since it involves the interchange of a relatively small amount of energy between the rocket vehicle and the deploying clamshells.
Figure 7—System motion with unaligned clamshells.

Figure 8—Forces and couples with unaligned clamshells.
Figure 9—System motion with aligned clamshells.

Figure 10—Forces and couples with aligned clamshells.
Figure 11—Effect of rocket-vehicle spin reversal on the system motion.

Figure 12—Effect of rocket-vehicle spin reversal on the hinge forces and couples.
Figure 13—Effect of rocket-vehicle spin on $C_{x_3}$.

Figure 14—Effect of rocket-vehicle acceleration on $C_{x_3}$. 

Figure 15—Effect of rocket-vehicle spin on $C_{x_2}$.

Figure 16—Effect of rocket-vehicle acceleration on $C_{x_2}$. 
Figure 17—Near free-flight displacements of an aligned roll-out clamshell released at 12.5 deg.

Figure 18—Near free-flight displacements of an aligned roll-out clamshell released at 15 deg.
Figure 19—Near free-flight displacements of an unaligned roll-out clamshell released at 15 deg.

Figure 20—Effect of rocket-vehicle spin reversal on the near free-flight of an aligned clamshell released at 15 deg.
Figure 21—Near free-flight displacements of an aligned roll-out clamshell released at 30 deg.

Figure 22—Near free-flight displacements of an aligned roll-out clamshell released at 60 deg.
Figure 23—Effect of rocket-vehicle spin reversal on the near free-flight of an aligned clamshell released at 60 deg.

Figure 24—Clamshell rotational rate.
References


Boylan, W. R., "Revise, True Degree of Freedom Particles Trajectory Program Code For the IBM 360.

Figure 25—Angular Rates For the System Using Slanted Clamps


Appendix A

Source Listing of Program "ROC" and a Data Deck
EXEC FORTRAN, PARM='NAME=ROC, DECK'
// SOURCE.SYSPUNCH DD DSN=EOECK1SYSOUT=R
// SOURCE.SYSIN DD *

2/21/69 - L.F.H.
C MOD. 8/21/69 - L.F.H.
C
C ... MAIN PROGRAM 'ROC' ...
C
C PROG. ROC AND ITS SUBSIDIARY SUBPROGRAMS MAY BE UTILIZED TO STUDY ROC00050
C BOTH THE DEPLOYMENT AND THE FREE FLIGHT PHASES OF CLAM SHELL EJECTION, ROC00060
C THE TYPE OF SYSTEM THAT CAN BE STUDIED IS BASED ON A UNIQUE CLAM SHELL ROC00070
C ROLL-OFF EJECTION CONCEPT. THE FREE FLIGHT PHASE OF A GIVEN CASE IN AR00080
C JOB RUN MAY BE SKIPPED IF DESIRED. THE DATA LOADING IS SET SO THAT ROC00090
C THE TERMINAL CARD IN EACH LOGICAL SUBSET OF CARDS REPRESENTING A CASE ROC00100
C INPUT BE PUNCH WITH AN INTEGER OF THE FORM 'LLLKJ' AND ADJUSTED AS ROC00110
C DESIRED BETWEEN COLUMNS 1 THROUGH 8, INCLUSIVE. IF 'J' IS ZERO, THE ROC00120
C FREE FLIGHT PHASE OF THE CASE IS SKIPPED. IF 'K' IS ZERO, THE CASE IS ROC00130
C THE LAST IN THE JOB RUN TO BE PROCESSED. THE CASE NO. IS OPTIONALLY ROC00140
C ENTERED BY PUNCHING UP TO THREE DIGITS IN 'LLL'; IF IT ROC00150
C CASE NO. IS EQUAL TO THE PRECEDING CASE NO. PLUS ONE.
C L.F.H. 8/21/69.
C
120 FORMAT ( '0',39X,'... J1 = ',1I1, ' ... ' )
130 FORMAT ( 3X,'RTIME = ','F8.3, 'SEC.' )
C
EXTERNAL SFT1, AUX1, DER1, AUX2, OUT1,
X SET2, AUX3, DER2, AUX4, OUT2
C
COMMON / LFHZ / NX(47), CBLOCK120,220
REAL*8 Z(250), H,X(3), Y(8,3), DER(814)
C
COMMON / DATA / Z, NEQ1, ZEQ2, J1, J2, J3, J4, J5
C
COMMON / EQUIVALENCE ( H, Z(44), ( X(1), Z(61) ), ( Y(1,1), Z(64) ),
2 ( DER(1,1), Z(91) ) )
C
300 CALL STIME
CALL LOAD( Z )
IF( NX(20) + NX(22) .GT. 0 ) GO TO 900
KK = RX00370
JJ = MOD( KK, 10 )
JK = MOD( KK/100 )/10
JL = MOD( KK,100000 )/100
IF( JL .GT. 0 ) J4 = JL
C
C ... 1ST ( DEPLOYMENT ) PHASE ...
C
CALL NIT1
CALL RK( X,Y, DER, 3, H, J1, J2,
X SET1, AUX1, DER1, AUX2, OUT1 )
IF( J1 .GT. 4 ) GO TO 500
CALL AUX1
CALL DER1( X,Y, DER, 1 )
CALL AUX2
CALL OUT1( 1 )
C
IFI JJ .EQ. 0 ) GO TO 550
C
...2ND ( FREE FLIGHT ) PHASE...
C
CALL NIT2
CALL RK ( X, Y, DER, 6, H, J1, 4,
X SET2, AUX3, DER2, AUX4, OUT2 )
IFI J1 .GT. 4 ) GO TO 500
CALL AUX3
CALL DER2 ( X, Y, DER, 6, 1 )
CALL AUX4
CALL OUT2 ( 1 )
GO TO 550
C
500 WRITE ( 6, 120 ) J1
550 CALL TTIME ( JITIME )
RTIME = FLUAT ( JITIME * 26 ) / 1000000.
WRITE ( 6, 130 ) RTIME
IFI JK .NE. 0 ) GO TO 300
GO TO 999
C
990 IFI JK .EQ. 0 ) GO TO 999
GO TO 300
C
999 STOP
END
C
2/22/67 - L.F.H.
C
MODE 10/23/68 - L.F.H.
C
SURROGATE LOAD
C
...PROD. VERS...
C
110 FORMAT ( 20A4 )
120 FORMAT ( 1X, I2, 5X, 20A4, 2X, Z8, 1X, Z8, 1X, Z8 )
130 FORMAT ( 15X, '...READ ERROR IN LOAD...' )
C
INTEGER K3, M1
COMMON / LFH2 / FWD, RD, RZ ( 4 ),
1 R1, R2, R3, R4, R5, R6, R7, R8, R9, RY ( 3 ),
2 N1, N2, N3, N4,
3 CARD ( 20 ), ALANK,
4 R30, PSW ( 2 ), K3, M1, C0LOCK ( 70, 220 )
C
FWD IS NOT USED BY SUPP. LOAD OR SUPP. EDATA.
C
RD CONTAINS SUPP. LOAD'S SAVE AREA ADDR.
C
RZ'S ARE NOT USED BY SUPP. LOAD OR SUPP. EDATA.
C
R1 CONTAINS THE RETURN ON AN SPICE ISSUED IN SUPP. EDATA.
C
R2 CONTAINS A(BOOT), THE SHIFTED B-ADDR. USED IN SUPP. EDATA.
C
R3 CONTAINS THE (CURRENT LOAD POINT) ON EACH RETURN FROM SUPP.
C
EDATA.
C
R4 CONTAINS A(LFH2), I.E., SUPP. EDATA'S SAVE AREA ADDR.
C
R5 CONTAINS A(CARD), I.E., A(LFH2+89).
C
R6 CONTAINS A(CURRENT CARD CHARACTER IMAGE).
C
R7 CONTAINS A(CARD+79), I.E., A(LFH2+167).
C
25
C R8 CONTAINS A(LOB), AN ADDR. INTERNAL TO SUBP. EDATA.
C R9 CONTAINS A(31).
C RY'S ARE NOT USED BY SUBP. LOAD OR SUBP. EDATA.
C N1 IS A BRANCHING CONTROL SET BY SUBP. EDATA FOR SUBP. LOAD.
C N2 IS A CARD COLUMN ERROR INDICATOR SET BY SUBP. EDATA.
C N3 IS A COUNT OF CARDS 'READ' BY SUBP. LOAD AND PROC. BY SUBP. EDATA.
C N4 = 32767 IS SET BY SUBP. LOAD TO SIGNAL A 'READING' ERROR.
C CARD(20) CONTAINS THE CHARACTERS OF THE CURRENT CARD IMAGE 'READ' BY SUBP. LOAD.
C SUBP. LOAD AND PROC. BY SUBP. EDATA.
C R30 CONTAINS A INIT. LOAD POINT.
C PSW CONTAINS THE 0-PSW WHENEVER SUBP. EDATA IS SUBJECTED TO A PROG.
C INTERRUPTION WHICH IS CHAINED BY THE 'SPIE' IN SUBP. EDATA.
C K3 = 1 IS SET BY SUBP. LOAD TO SIGNAL AN ENCOUNTER WITH AN EOF.
C M1 = 1 IS SET BY SUBP. LOAD AFTER ALL CARDS IN A FILE HAVE BEEN PROC. BY SUBP. EDATA.
C CBLOCK IS THE AREA WHERE A BLOCK OF CARD IMAGES ARE 'READ' IN BY SUBP. LOAD. THIS BLOCK MAY CONTAIN J1 CARD IMAGES OR ALL CARD IMAGES UP TO AN 'EOF', WHICHER IS LESS. WHEN THE NO. OF CARDS IN A FILE IS LESS THAN J1, SUBP. LOAD WILL 'READ' ALL OF THE CARDS IN THE FILE AND ENCOUNTER THE 'EOF'. IN SUCH A EVENT, SUBP. LOAD WILL SET K3 = 1 AND M1 = 0. AFTER THE LAST CARD IN THE FILE HAS BEEN PROC. BY SUBP. EDATA, SUBP. LOAD SETS M1 = 1.
C DATA
C 
C R / 4HRR../ /
C 1 J1 / 22O /,
C 2 K2 / O /
C NOTE...CBLOCK(20,M) REQUIRES THAT J1 .EQ. M.
C
C N1 = 1
C N2 = 0
C N3 = 0
C N4 = 0
C
C IF( K2 .LT. 1 ) GO TO 200
C .K1 = K2 + 1
C GO TO 320
C
C 200 DO 300 J = 1, J1
C 300 CBLOCK(I,J) = R
C .K1 = 1
C .K3 = 0
C M1 = 0
C
C READ(5,110,END=600,ERR=700 ) CBLOCK
C
C 320 DO 400 K = K1, J1
C IF( CBLOCK(I,K) .EQ. R ) GO TO 470
C .K2 = K
C
C 470 DO 350 J = 1,20
C 350 CARD(JJ) = CBLOCK(J,J)
C .N3 = N3 + 1
C
C
CALL EDATA
GO TO (400,450,370),NL
C
370 IF( N2 .EQ. 0 ) GO TO 400
   IF( PSW(I) .NE. 0.0 ) PRINT 120, N2, CARD, PSW, R4
   IF( PSW(I) .EQ. 0.0 ) PRINT 120, N2, CARD
400 CONTINUE
   IF( K3 .LT. 1 ) GO TO 200
C
450 IF( K2 .LT. J1 ) GO TO 500
470 K2 = 0
   IF( K3 .EQ. 1 ) M1 = 1
500 RETURN
C
600 K3 = 1
   GO TO 320
C
700 N4 = 32767
   PRINT 130
   GO TO 500
END
C
SUBROUTINE NIT1
C
...DATA INIT. FOR THE 1ST PHASE...
C
REAL*8 Z(250),
   T0,H0,Q(8),
   D(10),JCY(6),JZ(3),
   H,ETAZ,BETA,X,Y(8),
   DC(5),OS(5),
   TWPI,CRTD,CDTR,PID2,PID4
COMMON / DATA / Z,NEQ1,NEQ2,J1,J2,J3,J4,J5
   TWPI,CRTD,CDTR,PID2,PID4
   COMMON / CONS / Z,NEQ1,NEQ2,J1,J2,J3,J4,J5
   COMMON / CONS / TWPI,CRTD,CDTR,PID2,PID4
C
X = T0
H = H0
ETAZ = DATAN( D(2)/D(1) )
Q(3) = ETAZ*CRTD
Y(1) = Q(1)*TWPI
Y(2) = Q(2)*TWPI
Y(3) = ETAZ
D(5) = DSQRT( D(1)**2 + D(2)**2 )
C
...SET UP BETA AND THE PRIN. M. OF INERTIAS...
C
... SET UP BETA AND THE PRIN. M. OF INERTIAS...
IF( JCY(1) .EQ. JCY(3) ) GO TO 300
BETA = 0.500*DATA( 2.000*JCY(5)/( JCY(3) - JCY(1) ) )
IF( BETA .GT. PID4 ) BETA = BETA - PID2
IF( BETA + PID4 .LT. 0.000 ) BETA = BETA + PID2
GO TO 310
300 BETA = 0.000
310 DC(4) = DCOS( BETA )
DS(4) = DSIN( BETA )
JZ(1) = JCY(1)*DC(4)**2 + JCY(3)*DS(4)**2
1   = 2.000*JCY(5)*DC(4)*DS(4)
JZ(2) = JCY(2)
JZ(3) = JCY(1)*DS(4)**2 + JCY(3)*DC(4)**2
1   = 2.000*JCY(5)*DC(4)*DS(4)

C 990 RETURN
END
C 2/14/69 - L.F.H.
C MOD. 8/22/69 - L.F.H.
C
SUBROUTINE RK( X/1/Y/1/DER/NEQ/H/JL/JF/RK
1 SETH,AUX1,DERIV,AUX2,OUT )
C...RUNGE-KUTTA 4TH ORDER INTEGRATOR...
C FIXED STEP INTEGRATION EXCEPT FOR THE TERMINAL PROCEDURE.
C
C X - INDEPENDENT VARIABLE.
C Y'S - DEPENDENT VARIABLES.
C DER'S - DERIVATIVES OF THE Y'S.
C NEQ - NO. OF DERIVATIVE EQUATIONS.
C H - INTEGRATION STEP SIZE.
C JL - BRANCHING PARAMETER SET BY SUBP. SETH FOR SUBP. RK.
C JF - OUTPUT PRINT FREQUENCY.
C
C SUBP. SETH - ADJUSTS H DURING THE TERMINAL INTEGRATION PROCESS AND
C SETS JL = 1,2,3,4, OR 5 DEPENDING ON WHETHER H IS LEFT UNCHANGED OR
C ADJUSTED WITHOUT THE NEED TO RESET X(1) AND Y(1), THE INTEGRATION
C PROCESS IS TO BE ENDED, H IS CHANGED AND THE PRECEDING INTEGRATION
C STEP IS TO BE REPEATED WITH THE NEWER H-VALUE AND THE RESETED X AND
C Y-VALUES, H MUST BE CHANGED BEYOND THE MAX. ALLOWED NO. OF TIMES, OR
C AN ABNORMAL END OF THE INTEGRATION PROCESS IS REQUIRED, RESPECTIVELY.
C
C SUBP. SETH DEPENDS ON JL=0 WHENEVER SUBP. RK IS CALLED.
C SUBP. AUX1 - COMPUTES, I.E. UPDATES, THE REQ'D DATA FOR SUBP. DERIV.
C SUBP. DERIV - COMPUTES THE DERIV'S OF THE Y'S AT THE SUBSTEP POINTS.
C SUBP. AUX2 - COMPUTES, I.E. UPDATES, THE ADDITIONAL DATA FOR OUTPUT.
C SUBP. OUT - IS THE OUTPUT SUBPROGRAM.
C
C REAL*8 X(3),YINEQ,3,DFRINEQ,4,H,
C 1 CHI,H06
C J1 = 0
C JN = 0
C
400 X(2) = X(1)
00 410 K = 1,NEQ
CALL SETH1 X~Y,DERvMPJl 1
GO TO ( 420,990,400,500,500  ),J1
CONTINUE
CALL AUX1
CALL DERIV( X,Y,DER*NEQ,J )
IF1 MODI JN,JF ).NE. 0 ) GO TO 425
CALL AUX2
CALL OUT( JN )
CONTINUE
CHH = 0.500*H
DO 440 J = 2,4
IF( J .EQ. 4 ) CHH = H
X(I) = X(2) + CHH
DO 430 K = 1,NEQ
Y(K,1) = Y(K,2) + CHH*DER(K,J-1)
CALL AUX1
CALL DERIV( X,Y,DER,NEQ,J )
CONTINUE
HD6 = H/6.000
X(3) = X(2)
DO 470 K = 1,NEQ
Y(K,3) = Y(K,2)
Y(K,1) = DER(K,1) + 2.000*( DER(K,2) + DER(K,3) ) + DER(K,4)
470 Y(K,1) = Y(K,2) + HD6*Y(K,1)
JN = JN + 1
GO TO 400
CONTINUE
990 RETURN
END
C 2/14/69 - L.F.H.
C MOD. 8/22/69 - L.F.H.
C SUBROUTINE SETI( /X/ ,/Y/ ,/DER/ ,/NEQ/ ,/H/ ,/J1/ )
C ...
C RFAL=8 7(250),
X Y,y,y EPS,
X ITALY,DER(NEQ),
X H,X(NEQ),Y(NEQ),
X GAMO,TP/1,CDTS,CDTR,PID2,PID4
COMMON / DATA / Z,K(KK),
EQUIVALENCE
**C**

**COMMON / CONS** / TWP1,CRT0,C1TR,P1D2,P1D4

**C**

IFI J1 .EQ. 0 ) JC = 0

**C**

***CHECK FOR TERMINAL CONDITIONS***

**C**

GAMD = ( Y3,1/ ETAZ ) * CRTD

IFI GAMD .LT. 0.000 ) GO TO 500

IFI GAMD .GT. 0.000 ) LE. YFPS ) GO TO 200

IFI J1 .EQ. 0 ) GO TO 100

IFI Y(2,1) .LE. 0.000 .AND. DER(2,1) .LE. 0.000 ) GO TO 500

**C**

***SET J1 AS REQUIRED***

**C**

100 J1 = 1
GO TO 990

**C**

200 J1 = 2
GO TO 990

**C**

300 JC = JC + 1

IFI JC .GT. J3 ) GO TO 400

IFI J1 .EQ. 0 ) GO TO 500

H = 0.500#8

X(1) = X(3)

DO 330 K = 1,NEQ

330 Y(K,1) = Y(K,3)

J1 = 3
GO TO 990

**C**

400 J1 = 4
GO TO 990

**C**

500 J1 = 5
GO TO 990

**C**

990 RETURN

END

**C**

2/14/69 - L.F.H.

**C**

MOD. 7/07/69 - L.F.H.

**C**

SUBROUTINE AUX1

**C**

***DATA UPATER FOR THE 1ST PHASE DERIV. SUBP***

**C**

REAL*8 Z(250),

1 D(101),M,JCY(6),

2 JYX1,GAMZ,ETAZ,Y(8),

3 DCF(5),DCF(9),

4 F(6),F23,

5 CQM,QET,

6 A,B,C,DD,U,V

**COMMON / DATA / Z,NEQ1,NEQ2,J1,J2,J3,J4,J5**

AUX0080

AUX0090

AUX0100

AUX0110

AUX0120

AUX0130

AUX0140

AUX0150
EQUIVALENCE
1 ( D1(1),Z(11) ),( M1,Z(21) ),( JCY(1),Z(22) ),
2 ( JVX1,Z(31) ),( GAM,Z(32) ),( ETA2,Z(36) ),
3 ( Y(1),Z(64) ),
4 ( DC(1),Z(131) ),( DS(1),Z(136) ),
5 ( F(1),Z(141) ),( F23,Z(147) )
COMMON / DAX1 / A,B,C,D,U,V

C
C D!1(1) = DCOS( Y(3) )
DS(1) = DSIN( Y(3) )

C GAM = Y(3) - ETA2
DC(2) = DCUS( GAM )
DS(2) = DSIN( GAM )
C D(7) = DSQRT( D(1)**2 + D(5)**2 - 2.00000#D(1)*D(1)*DC(1) )
C F(2) = M*( Y(2)**2 )*D(5)
F(3) = 2.00000#M*Y(1)*Y(2)*D(5)
F23 = F(2) - F(3)
CALL FF6
C DD = 2.00000#( JCY(1) + M**2 * D(5)**2 )
A = JVX1 + 2.00000#( JCY(1) + M*( D(7)**2 ) )
B = - DD + 2.00000#M*Y(5)*D(11)*DC(1)
C = B

C QOM = 0.00000
QFT = F(6)*D(1)
U = QOM + 2.00000#F23*D(1)*DS(1)
V = QFT + 2.00000#M*( Y(1)**2 )*D(5)*D(1)*DS(1)

C 990 RETURN
END
C 2/14/69 - L.F.H.
C
C SUBROUTINE DER1( X,Y,DER,NEQ,J )
C
C . . . DERIV. FQ'S. FOR THE 1ST PHASE...
C REAL#8
X,Y(NEQ),DER(NEQ,4),
1 A,B,C,D,U,V,DET
C
COMMON / DBX1 / A,B,C,D,U,V
C
DET = A*D - R*C
C
DER(1,J) = ( D#U - B#V )/DET
DER(2,J) = ( A#V - C#U )/DET
DER(3,J) = Y(2)

C 990 RETURN
END
C 2/14/69 - L.F.H.
SUBROUTINE AUX2

... DATA UPDATE FOR THE 1ST PHASE OUTPUT ...
CY(2) = MY(2) + FY(1)*D(2) - FY(3)*O(3) + F(6)*D(4)
CY(3) = MY(3) + FY(1)*D(1) + FY(2)*D(3)

C
CX(1) = CY(1)
CX(2) = CY(2)*DC(2) + CY(3)*DS(2)
CX(3) = CY(3)*DC(2) - CY(2)*DS(2)

C
GAMD = GAM*CRTD

C
990 RETURN
END
C 2/18/69 - L.F.H.
C SUBROUTINE FAX1
C
* DUMMY LONGIT ACCELERATION SUBP...
C
RETURN
END
C 2/18/69 - L.F.H.
C MOD. 7/07/69 - L.F.H.
C SUBROUTINE FF6
C
REAL*8 Z(250),
X F(6)
COMMON / DATA / Z,NEQ1,NEQ2,J1,J2,J3,J4,J5
EQUIVALENCE
X ( F(1),7(141) )

C
300 F(6) = 0.000
C 990 RETURN
END
C 3/26/69 - L.F.H.
C MOD. 9/24/69 - L.F.H.
C SUBROUTINE OUT1 JJ
C
...OUTPUT SUBP. FOR THE 1ST PHASE...
C
110 FORMAT( 'I' / 'U',39X,'...BASE DATA...'/ LX
X / 5X,'TO - INITIAL TIME ( SEC ).'
X / 5X,'THO - INITIAL INTEGRATOR TIME STEP SIZE ( SEC ).'
X / 5X,'Q(1) ...Q(3) - INITIAL OMEGA, ETA-DOT, AND ETA '
X / 5X,'RPS, RPS, DEG .'
X / 5X,'ID(1) ...ID(8) - CLAMSHELL GEOMETRIC PARAMETERS ( FT ).'
X / 5X,'I PSLG, TSI ( PSU ).'
X / 5X,'JCY(1) ...JCY(6) - CLAMSHELL Y-FRAME '
X / 5X,'MOMENTS AND PRODUCTS OF INERTIA ( SLUG*FT**2 ).'
X / 5X,'MOMENTS OF INERTIA ( SLUG*FT**2 ).'
X / 5X,'JZ(1) ...JZ(3) - CLAMSHELL Z-FRAME I.E. PRINCIPAL '
X / 5X,'( SLUG*FT**2 ).'
X / 5X,'YF - TERMINAL GAMMA ( DEG ).'
X / 5X,'YT - TERMINAL GAMMA ( DEG ).'
X / 5X,'1EYPS - TERMINAL GAMMA CONVERGENCE CRITERION ( DEG ),' 1OUT0220
X / 5X,'AXI - SYSTEM MAX ACCELERATION ( FT/SEC**2 ),' 1OUT0230
115 FORMAT ('1', '0.', '3X,', 'CASE NO. ', '13,5X,10A8', ' / 1X
X / 6X,'TO,H0,Q(1),', '1P5D12.4
X / 12X,'D(1),', '1P5D12.4
X / 8X,'M,JCY(1),', '1P7D12.4
X / 6X,'JZ(1),JXV1, ', '1P4D12.4
X / 5X,'Y1,EYPS,AX1, ', '1P3D12.4
120 FORMAT ('1', '0.', '3X,', 'CASE NO. ', '13,5X,10A8
X / 30X,'1ST PHASE OUTPUT', ' / 1X
X / 5X,'T - ELAPSED TIME ( SEC ),'
X / 5X,'GAMD - CLAMSHELL ROLL-OUT ANGLE ( DEG ),'
X / 5X,'YY(3) - CLAMSHELL ETA-ANGLE ( DEG ),'
X / 5X,'YY(2) - CLAMSHELL ROLL-OUT RATE ( RPS ),'
X / 5X,'YY(1) - SYSTEM ROLL RATE ( RPS ),'
X / 5X,'DER(2) - CLAMSHELL ROLL-OUT ACCELERATION ( RAD/SEC**2 ),'
X / 5X,'DER(1) - SYSTEM ROLL ACCELERATION ( RAD/SEC**2 ),'
X / 5X,'FIJ - INERTIAL AND APPLIED FORCE ( LB ),'
X / 5X,'FX(1) - X-FRAME HINGE FORCE COMPONENTS ( FT-LB ),'
X / 5X,'CX(1) - X-FRAME HINGE COUPLE COMPONENTS ( FT-LB ),'
X / '0' / '55X',....
X / '0' / '15X', 'T', '9X','GAMD', '8X','YY(3)',
X / '0' / '9X','YY(2)', '8X','YY(1)', '7X','DER(2)', '6X','DER(1)',
X / '0' / '25X','F(1)', '8X','F(2)', '8X','F(3)',
X / '0' / '2X','F(4)', '8X','F(5)', '8X','F(6)',
X / '0' / '25X','FX(1)', '7X','FX(2)', '7X','FX(3)',
X / '0' / '25X','CX(1)', '7X','CX(2)', '7X','CX(3)
130 FORMAT ('1', '0.', '3X,', 'CASE NO. ', '13,5X,10A8
X / 30X,'1ST PHASE OUTPUT', ' / 1X
X / 5X,'T - ELAPSED TIME ( SEC ),'
X / 5X,'GAMD - CLAMSHELL ROLL-OUT ANGLE ( DEG ),'
X / 5X,'YY(3) - CLAMSHELL ETA-ANGLE ( DEG ),'
X / 5X,'YY(2) - CLAMSHELL ROLL-OUT RATE ( RPS ),'
X / 5X,'YY(1) - SYSTEM ROLL RATE ( RPS ),'
X / 5X,'DER(2) - CLAMSHELL ROLL-OUT ACCELERATION ( RAD/SEC**2 ),'
X / 5X,'DER(1) - SYSTEM ROLL ACCELERATION ( RAD/SEC**2 ),'
X / 5X,'FIJ - INERTIAL AND APPLIED FORCE ( LB ),'
X / 5X,'FX(1) - X-FRAME HINGE FORCE COMPONENTS ( FT-LB ),'
X / 5X,'CX(1) - X-FRAME HINGE COUPLE COMPONENTS ( FT-LB ),'
X / '0' / '55X',....
X / '0' / '15X', 'T', '9X','GAMD', '8X','YY(3)',
X / '0' / '9X','YY(2)', '8X','YY(1)', '7X','DER(2)', '6X','DER(1)',
X / '0' / '25X','F(1)', '8X','F(2)', '8X','F(3)',
X / '0' / '2X','F(4)', '8X','F(5)', '8X','F(6)',
X / '0' / '25X','FX(1)', '7X','FX(2)', '7X','FX(3)',
X / '0' / '25X','CX(1)', '7X','CX(2)', '7X','CX(3)
140 FORMAT ('1', '0.', '3X,', 'CASE NO. ', '13,5X,10A8
X / 30X,'1ST PHASE OUTPUT', ' )
X / 38X,'1ST PHASE OUTPUT', ' / 1X
150 FORMAT ('1', '0.', '3X,', 'CASE NO. ', '13,5X,10A8
X / 30X,'1ST PHASE OUTPUT', ' / 1X
C
REAL*8 Z(250),
X TO,H0,Q(3),D(8),M,JCY(6),
X JZ(3),JXV1,GAMD,
X Y1,EYPS,AX1,
X X,Y(3),DER(3),F(6),FX(3),CX(3),
X TITLE(10)
REAL*8 YY(3)
REAL*8 TQPI,CRT0,CDT0,P1D2,P1D4
COMMON / CONS / TQPI,CRT0,CDT0,P1D2,P1D4
COMMON / DATA / Z,QEQ1,QEQ2,JL,J2,J3,J4,J5
EQUIVALENCE
X ( TO,Z(1),H0,Z(2),Q(1),Z(3), ),
X ( D(1),Z(11),M,Z(21),JCY(1),Z(22), ),
X ( JZ(1),Z(29),JXV1,Z(31),GAMD,Z(33), ),
X ( Y1,EYPS,Z(43),AX1,Z(45), ),
X ( X,Z(61),Y11,Z(64),DER(1),Z(91), ),
X ( F11,Z(141), ),
X ( FX(1),Z(151),CX(1),Z(174), ),
X ( TITLE(1),Z(241), )
C
DATA JK/ 0, NCASE/ 0 /
IF (JJ .NE. 0) GO TO 400
IF (NCASE .NE. J4) GO TO 230
NCASE = J4 + 1
J4 = NCASE
GO TO 240
230 NCASE = J4
240 IF (JK .EQ. 0) WRITE (6,110)
250 IF (JK .NE. 0) WRITE (6,115)
C
WRITE (6,120) NCASE,TITLE,X
X
X
X
X
X
X
300 JK = 255
C
WRITE (6,130) NCASE,TITLE,JL = 20
C
400 IF (MOD(JL,56) .NE. 0) GO TO 500
WRITE (6,140) NCASE,TITLE,JL = 0
C
500 YY(1) = Y(1)/TWPI
YY(2) = Y(2)/TWPI
YY(3) = Y(3)*CRTD
WRITE (6,150) X
X
X
X
X
X
JL = JL + 4
C
990 RETURN
END
C 2/26/69 - L.F.H.
C MOD. 9/03/69 - L.F.H.
C SUBROUTINE NIT2
C
... DATA INIT. FOR THE 2ND PHASE ...
C
REAL*8 Z(250),
X
X
X
X
X
X
X
X
X
X
X
COMMON / DATA / Z,NEQ1,NEQ2,J1,J2,J3,J4,J5
EQUIVALENCE
X ( D(1), Z(11) ),
X ( GAM, Z(32) ), ( X, Z(41) ),
X ( H2, Z(44) ), ( BETA, Z(47) ),
X ( XF, Z(51) ),
X ( X2, Z(61) ), ( Y(1), W(1), Z(64) ),
X ( DC(1), Z(131) ), ( DS(1), Z(136) ),
X ( D7CA, Z(141) ), ( D7SA, Z(142) ),
X ( DXCM(1), Z(151) ), ( P(1), Z(161) ),

COMMON / CONS / TWP1, CTRD, CDR, PID2, PID4

EQUIVALENCE ( D8M3, DIM2, YLM2, ZZZ )

XF = X

... BODY POINT DISPLACEMENTS IN THE Z-FRAME...

D8M3 = D(8) - D(3)
P1(1,1) = D8M3*D0C(4) - D(2)*DS(4)
P(2,1) = 0.000
P(2,2) = 0.000
P(2,3) = D(1) - D(2)
P(2,4) = - D(1)
P(3,1) = - D(2)*DC(4) - D8M3*DS(4)
P(3,2) = - D(3)*DC(4) + D1M2*DS(4)
P(3,3) = D(1)
P(3,4) = P(3,3)

... BODY C.M. DISPLACEMENT RATES...

D7CA = D(7)*DC(3)
D7SA = D(7)*DS(3)
DXCM(2) = Y(2)*D(5)*DS(11) - Y(11)*D7SA
DXCM(3) = Y(2)*D(5)*DC(1) + Y(11)*D7CA

... INIT. BODY FIXED Z-FRAME ANGULAR RATES...

YLM2 = Y(11) - Y(2)
W(1) = YLM2*DC(4)
W(2) = 0.000
W(3) = - YLM2*DS(4)

... INIT. EULERIAN ANGLES...

SEE NOTES IN SUBP. DER2 AND SUBP. AUX4 ON ROTATIONAL TRANSFORMATION.

W(4) = - GAM
W(5) = 0.000
W(6) = - BETA

... SET UP TIME STOP AND 'H'...
ZZZ = DAHS( YIM2 )
IF( ZZZ .LT. PI04 ) ZZZ = PI04
ZZZ = PID2/ZZZ
XT = X + ZZZ
H = ZZZ/128.000

C 990 RETURN
END
C 2/27/69 - L.F.H.
C MOD. 8/20/69 - L.F.H.
C
SUBROUTINE SET2( T,W,DER,NEQ,H,J1 )
C
REAL*8 Z(290),
X T(H),
X T(NEQ),W(NEQ,3),DER(NEQ,4),
X H1,H2
COMMON / DATA / Z,KKK(6),J5
EQUIVALENCE
X ( T,H(41) )
C
IF( J1 .EQ. 0 ) JC = 0
C
IF( J1 .EQ. 3 ) GO TO 255
IF( J5 .EQ. 0 ) GO TO 250
J5 = 0
CALL SP1E( 0 )
JC = JC + 1
IF( JC .GE. 5 ) GO TO 500
H1 = H
H = 2.000*H
T(11) = T(3)
DO 200 K = 1,NFQ
200 W(K,1) = W(K,3)
J1 = 3
C
230 IF( T(11) .EQ. TT ) GO TO 300
IF( T(11) + H .LE. TT ) GO TO 990
H2 = TT - T(11)
JC = 0
IF( J1 .EQ. 3 .AND. H1 .EQ. H2 ) GO TO 500
H = H2
GO TO 990
C
250 IF( JC .EQ. 0 ) GO TO 255
H = H*( 0.500**JC )
JC = 0
255 J1 = 1
GO TO 230
C
300 J1 = 2
GO TO 990
C
200 J1 = 5
990 RETURN
END
C 2/26/69 - L.F.H.
C MOD. 7/07/69 - L.F.H.
C
SUBROUTINE AUX3
C
...DATA UPDCATER FOR THE 2ND PHASE DERIV. SUBP...
C
REAL*8 Z(250),
1 W(8),
2 DS(5)

COMMON / DATA / Z,NEQ1,NEQ2,J1,J2,J3,J4,J5
EQUIVALENCE
1 ( W(1),Z(64) ),
2 ( DC(1),Z(131) ), ( DS(1),Z(136) )
C
...COSINES AND SINES OF THE EULRIAN ANGLES...
C
DO 300 J = 1,3
DC(J) = DCOS( W(J+3) )
300 DS(J) = DSIN( W(J+3) )

C
...CHECK THE COSINE OF THE 2-ANGLE...
C
IF( DC(2) .NE. 0.0D0 ) GO TO 990
CALL SPIE( 1 )
J5 = 255

990 RETURN
END
C 2/24/69 - L.F.H.
C MOD. 7/07/69 - L.F.H.
C
SUBROUTINE DER2( T,W,DER,NEQ,J )
C
...DERIV. EQ'S. FOR THE 2ND PHASE...
C
REAL*8 T,NEQ1,DER(NEQ,4)
REAL*8 Z(250),
1 JZ(3),DC(5),DS(5)

COMMON / DATA / Z,NEQ1,NEQ2,J1,J2,J3,J4,J5
EQUIVALENCE
1 ( JZ(1),Z(28) ), ( DC(1),Z(131) )
2 ( DS(1),Z(136) )
C
...EULER'S EQ'S. OF MOTION FOR FREE FLIGHT...
C
DER(1,J) = W(2)*W(3)*( JZ(2) - JZ(3) )/JZ(1)
DER(2,J) = W(3)*W(1)*( JZ(3) - JZ(1) )/JZ(2)
DER(3,J) = W(1)*W(2)*( JZ(1) - JZ(2) )/JZ(3)
C
...DERIV. EQ'S. FOR EULERIAN ANGLES...
C
THE ROTATIONAL TRANSFORMATION FROM THE INERTIAL FRAME TO THE
C BODY FIXED PRINCIPAL AXIS FRAME AT THE BODY C.M. INVOLVES THREE
C SUCCESSIVE ROTATIONS: A ROTATION ABOUT THE 1-AXIS THROUGH THE 1-ANGLE,
C A ROTATION ABOUT THE 1ST INTERMEDIATE 3-AXIS THROUGH THE 2-ANGLE, AND
C A ROTATION ABOUT THE 2ND INTERMEDIATE 2-AXIS THROUGH THE 3-ANGLE.
C
C DER(4,J) = ( W(3)*DS(3) + W(1)*DC(3) ) / DC(2)
C DER(5,J) = W(3)*DC(3) - W(1)*DS(3)
C DER(6,J) = W(2) + DER(4,J)*DS(2)

C 990 RETURN
C END
C
G 2/24/69 - L.F.H.
G MOD. 9/03/69 - L.F.H.
G
C SUBROUTINE AUX4
G
C
C REAL*8
C X TF,TD,
C X T,W,B,
C X X DC(5),DS(5),
C X X D7CA,DTSA,
C X X XCM(3),XCMI3),
C X X P(3,4),X(3,4),
C X X A(3,3)
C COMMON / DATA /
C Z,NEC2,J1,J2,J3,J4,J5
C EQUIVALENCE
C X ( TF,Z(51) ),
C X ( T,W(61) ),( W(1),Z(64) ),
C X ( DC(11),Z(131) ),( DS(1),Z(136) ),
C X ( D7CA,Z(141) ),( DTSA,Z(142) ),
X ( XCM(11),Z(151) ),( XCM(1),Z(154) ),
X ( P(1,1),Z(161) ),( X(1,1),Z(221) )
G
C COMMON / DATA /
C Z,NEC2,J1,J2,J3,J4,J5
C EQUIVALENCE
C X ( TF,Z(51) ),
C X ( T,W(61) ),( W(1),Z(64) ),
C X ( DC(11),Z(131) ),( DS(1),Z(136) ),
C X ( D7CA,Z(141) ),( DTSA,Z(142) ),
X ( XCM(11),Z(151) ),( XCM(1),Z(154) ),
X ( P(1,1),Z(161) ),( X(1,1),Z(221) )
G
C
C ...BODY C.M. DISPLACEMENTS...
C
X XCM(1) = O,0,0,0
X TD = T - TF
X XCM(2) = DXCM(2)*TD + D7CA
X XCM(3) = DXCM(3)*TD + DTSA
C
C THE ROTATIONAL TRANSFORMATION FROM THE INERTIAL FRAME TO THE
C BODY FIXED PRINCIPAL AXIS FRAME AT THE BODY C.M. INVOLVES THREE
C SUCCESSIVE ROTATIONS: A ROTATION ABOUT THE 1-AXIS THROUGH THE 1-ANGLE,
C A ROTATION ABOUT THE 1ST INTERMEDIATE 3-AXIS THROUGH THE 2-ANGLE, AND
C A ROTATION ABOUT THE 2ND INTERMEDIATE 2-AXIS THROUGH THE 3-ANGLE.
C
C THE FOLLOWING ELEMENTS ARE COMPONENTS OF THE INVERSE OF THE TRANSFORM.
C FORMATION MATRIX FOR ROTATING THE INERTIAL FRAME INTO THE BODY FIXED
C PRINCIPAL AXIS FRAME AT THE C.M. OF THE BODY.
C
A(1,1) = DC(2)*DC(3)
A(1,2) = - DS(2)
A(1,3) = DC(2)*DS(3)
A(2,1) = DS(1)*DS(3) + DC(1)*DS(7)*DC(3)
C
A(2,2) = DC(1)*DC(7)  
A(2,3) = -DS(1)*DC(3) + DC(1)*DS(2)*DS(3)  
A(3,1) = -DC(1)*DS(3) + DS(1)*DS(2)*DC(3)  
A(1,2) = DS(1)*DC(2)  
A(3,3) = DC(1)*DC(3) + DS(1)*DS(2)*DS(3)

... BODY POINT DISPLACEMENTS...

DO 500 J = 1,4
DO 500 K = 1,3
X(K,J) = XCM(K)
DO 500 L = 1,3
500 X(K,J) = X(K,J) + A(K,L)*P(L,J)

RETURN
END

C 3/26/69 - L.F.H.
C MOD. 9/03/69 - L.F.H.
C
SUBROUTINE OUT2(JJ)

... OUTPUT SUBP. FOR THE 2ND PHASE...

130 FORMAT('1',/ 'OCASE NO. ',I3,5X,10A8  
X / 38X,'2ND PHASE OUTPUT',/ 1X  
X / 5X,'T - ELAPSED TIME (SEC)',/ 1X  
X / 5X,'XCM,YCM,ZCM - C.M. FREE FLIGHT DISPLACEMENT (FT)',/ 1X  
X / 5X,'X(J),Y(J),Z(J) - J-TH POINT FREE FLIGHT DISPLACEMENTS',/ 1X  
X / 'T (FT)',/ 1X  
X / '0' / 55X,'....'  
X / '*0',14X,'T',10X,'XCM',9X,'YCM',9X,'ZCM',  
X / 9X,'X(1)',8X,'Y(1)',8X,'Z(1)',  
X / '*0',25X,'X(2)',8X,'Y(2)',8X,'Z(2)',  
X / 8X,'X(3)',8X,'Y(3)',8X,'Z(3)',  
X / '*0',25X,'X(4)',8X,'Y(4)',8X,'Z(4)'  
140 FORMAT('1',/ 'OCASE NO. ',I3,5X,10A8  
X / 38X,'2ND PHASE OUTPUT')
150 FORMAT('0',9X,1P3012.4,/(22X,1P6012.4))

C REAL*8  
Z(250),  
T,  
XCM(3),X(3,4),  
TITLE(10)

COMMON / DATA / Z,NEQL,NEQO,J1,J2,J3,J4,J5  
EQUIVALENCE  
X ( T,Z(61) ),  
X ( XCM(1),Z(154) ), ( X(1,1),Z(201) ),  
X ( TITLE(1),Z(241) ),  
X ( NCASE,J4 )

C IF( JJ .NE. 0 ) GO TO 400  
WRITE( 6,130 ) NCASE,TITLE  
JL = 16

400 IF( MOD(JL,56) .NE. 0 ) GO TO 500

20OUT0340  
20OUT0350  
20OUT0360  
20OUT0370  
20OUT0380
WRITE( 6,140 ) NCAS,TITLE
JL = 0
C
500 WRITE( 6,150 ) T,XCM,X
JL = JL + 4
C
990 RETURN
END

/* EXEC ASSEMBLR, PARM='LOAD,DECK'
//SOURCE. SYSPUNCH DD DSN=6DECK, SYSSOUT=8
//SOURCE. SYSIN DD *
EDAT  TITLE 'DATA-ENTRY AND INITIALIZATION SECT.'
PRINT DATA
* 2/22/67 - L.F.H.
* MOD. 5/15/70 - L.F.H.
SPACE 1
* SUBP. EDATA PROCESSES DATA CARDS 'READ' BY SUBP. LOAD AND STORES
* THE PROCESSED DATA ITEMS AS DIRECTED. CHARACTER, FULL AND DOUBLE
* WORD DECIMAL ( WHICH TACL. FULL WORD INTEGER AS WELL AS SHORT AND
* LONG REAL ) , HALF WORD DECIMAL INTEGER, AND FULL WORD HEXADECIMAL
* DATA ARE PROCESSED.
* SUBP. EDATA IS MOST EFFICIENT WHEN DIRECTED TOWARD THE LOADING OF
* BLOCKS OF STORAGE SUCH AS A COMMON AREA OR A LARGE ARRAY CONTAINING
* THE VARIOUS TYPES OF DATA REQUIRED BY A PROCESSING PROGRAM SINCE IT
* TENDS TO LOAD THE PROCESSED DATA ITEMS INTO SEQUENTIALLY HIGHER AND
* HIGHER LOCATIONS. IT MAY BE DIRECTED TO SCATTER LOAD ONLY THE RE-
* QUED DATA ITEMS, I.E., ALL OF THE STORAGE BLOCK NEED NOT BE LOADED.
* THE CURRENT LOAD POINT MAY BE SHIFTED AS REQ'D TO SKIP OVER SECTIONS
* OF STORAGE AT ANY TIME. THIS SHIFT IS COMPUTED RELATIVE TO THE
* INITIAL LOAD POINT.
* CHARACTER DATA ARE STORED WITHOUT CHANGE BYTE-BY-BYTE; HENCE, THE
* CURRENT LOAD POINT CAN BE SHIFTED OFF A HALF WORD AS WELL AS A FULL
* WORD AND DOUBLE WORD BOUNDARY. IT IS ADVISABLE TO USE THE INITIAL
* LOAD POINT RESET AND SHIFT FEATURE OF SUBP. FDATA FOLLOWING THE LOAD-
* ING OF CHARACTER DATA.
* THE LOAD POINT FOR THE FULL AND DOUBLE WORD DECIMAL DATA AS WELL
* AS THE HEXADECIMAL AND HALF WORD DECIMAL INTEGER DATA MUST BE AT THE
* APPROPRIATE BYTE BOUNDARIES.
* SUBP. EDATA PROCESSES ITS OWN PROGRAM INTERRUPTS. IT SAVES THE
* ADDRESS OF 'THE NEXT INSTRUCTION' AND THE OLD PSW AND RESETS THE NEXT
* INSTRUCTION ADDRESS BEFORE RETURNING CONTROL TO THE CONTROL PROGRAM.
* THE CARD ERROR COLUMN NUMBER, THE CARD IMAGE, AND THE OLD PSW ARE
* PRINTED BY SUBP. LOAD.
* SUBP. EDATA CAN DETECT CERTAIN PROCESSING ERRORS AND GENERATE THE
* CARD COLUMN NUMBER AT WHICH THE ERROR WAS DETECTED. THE LOADING OF
* ALL SUBSEQUENT DATA IS SUSPENDED AS IT IS WHEN A PROG. INTERRUPT IS
* PROCESSED. HOWEVER, SUBSEQUENT DATA CARDS ARE CHECKED FOR ERRORS
* UNTIL A RETURN TO THE CALLER OF SUBP. LOAD IS EXECUTED. ONLY ONE
* ERROR PER CARD CAN BE DETECTED AND PROCESSED. DATA ITEMS ON A GIVEN
* CARD WHICH FOLLOW A DETECTED ERROR CANNOT BE CHECKED. SUBP. LOAD
* PRINTS THE CARD ERROR COLUMN NUMBER AND THE CARD IMAGE IN SUCH CASES.
* FOR DETAILS ON SUBP. LOAD AND SUBP. EDATA, CALL L.F.HATAKEYAMA,
* NASA-GSFC, CODE 721, K4047. 
SPACE 1
EDATA

CSECT  EOAT0440
SPACE 1  EDAT0450
A  EDAT0460
B  EDAT0470
C  EDAT0480
D  EDAT0490
E  EDAT0500
F  EDAT0510
EJECT  EDAT0520
*  EDAT0530
ENTRY BUST  EDAT0540
 USING +F  EDAT0550
 R A100  EDAT0560
 DC CL6'5EDATA'  EDAT0570
 A100  EDAT0580
 STM E+4,12(D)  EDAT0590
 L B,+4(D)  EDAT0600
 L A24(D)  EDAT0610
 L =ALFH2  EDAT0620
 ST D,4(D)  EDAT0630
 ST 4,8(D)  EDAT0640
 LR D,*  EDAT0650
 SPACE 1  EDAT0660
 LA F,BUST-EDATA(F)  EDAT0670
 USING BUST,F  EDAT0680
 B A120  EDAT0690
*  EDAT0700
 BUST  EDAT0710
 B A200  EDAT0720
 DC CL6'BUST '  EDAT0730
 A200  EDAT0740
 NI A212+1,X'0F'  EDAT0750
 SPACE 1  EDAT0760
 A210  EDAT0770
 LR 2,F  EDAT0780
 USING BUST,2  EDAT0790
 DRUP F  EDAT0800
 SPACE 1  EDAT0810
 A212  EDAT0820
 RC 15,E  EDAT0830
 SPACE 1  EDAT0840
 MVC 176(8,4,4(1)  EDAT0850
 MVC 9(3,11)=AL3(C110)  EDAT0860
 DI A212+1,X'0F'  EDAT0870
 RCR 15,E  EDAT0880
*  EDAT0890
 A300  EDAT0900
 SPIE BUST,(11,15)  EDAT0910
 SPACE 1  EDAT0920
 STM 1,2,24(4)  EDAT0930
 CLC 821,2,4)=H'1'  EDAT0940
 BH A400  EDAT0950
 L 3,0(A)  EDAT0960
 ST 3,172(4)  EDAT0970
 LA 9,85(4)  EDAT0980
 LA 7,91(5)  EDAT0990
 LA 8,6OB  EDAT1000
 LA 9,3  EDAT1010
 STM 1,9,24(4)  EDAT1020
 EJECT  EDAT1030
 A400  EDAT1040
 LM 1,9,24(4)  EDAT1050
 RESET R1 - R9.  EDAT1060

RESET & SAVE 6...
RESET & SAVE 6...

CLEAR THE 'PSW' CELLS.
CLEAR THE 'PSW' CELLS.

ZERO LOP & HOLD.
ZERO LOP & HOLD.

SET UP RA, RB, RE, & RF...
SET UP RA, RB, RE, & RF...

ENABLE THE BR. AT A408.
ENABLE THE BR. AT A408.

COMPUTE THE LOADING OFFSET...
COMPUTE THE LOADING OFFSET...

DISABLE THE BR. AT A408.
DISABLE THE BR. AT A408.

RESET RB.
RESET RB.

SET UP RA, RB, RE, RF....
SET UP RA, RB, RE, RF....

CHECK THE CARD COL. 9 CHAR...
CHECK THE CARD COL. 9 CHAR...

SET UP THE CURRENT LOAD POINT...
SET UP THE CURRENT LOAD POINT...

SET UP RA, RB, RE, RF....
SET UP RA, RB, RE, RF....

CHECK THE CARD COL. 10 CHAR...
CHECK THE CARD COL. 10 CHAR...

BR. IF .EQ. AN ALLOWED CHAR.
BR. IF .EQ. AN ALLOWED CHAR.

INCR. RR.
INCR. RR.

LOGP...
LOGP...

BR. OUT AS REQ'D...
BR. OUT AS REQ'D...

TITLE 'EDATA-C DATA, BLANK AND RETURN PROC. SECTIONS'
TITLE 'EDATA-C DATA, BLANK AND RETURN PROC. SECTIONS'

*  ***  
*  ***  

EDAT0990
EDAT1000
EDAT1010
EDAT1020
EDAT1030
EDAT1040
EDAT1050
EDAT1060
EDAT1070
EDAT1080
EDAT1090
EDAT1100
EDAT1110
EDAT1120
EDAT1130
EDAT1140
EDAT1150
EDAT1160
EDAT1170
EDAT1180
EDAT1190
EDAT1200
EDAT1210
EDAT1220
EDAT1230
EDAT1240
EDAT1250
EDAT1260
EDAT1270
EDAT1280
EDAT1290
EDAT1300
EDAT1310
EDAT1320
EDAT1330
EDAT1340
EDAT1350
EDAT1360
EDAT1370
EDAT1380
EDAT1390
EDAT1400
EDAT1410
EDAT1420
EDAT1430
EDAT1440
EDAT1450
EDAT1460
EDAT1470
EDAT1480
EDAT1490
EDAT1500
EDAT1510
EDAT1520
EDAT1530
Enable the RR's at C102...

Incr., save, & check R6...

BR. out if past Card end.

Look for the ' mark...

BR. out when found.

**

Check for the '' mark.

BR. out if not a '' mark.


Save R6.

Check for preceding errors...

BR. to avoid data loading.

Move a character.

Incr. R3.

Set up trouble indic...

Indic. trouble.

Check for the '' mark.

BR. out if not a '' mark.


Save R6.

Disable the BR. at C102.

Disable the BR. at C300.

Indic. no error.

Save the current load point.

Reset R1...

...to reset the old P.I.E.

Reset R0...

...and restore the other R's.

Indic. return.

Title 'EDATA-D DATA PROC. SECTION'

* * *
SET UP RA & RB...

ZERO HOP, LOP, HOLD, & EXP.

SET UP TCW.

SPACE 2

D200

LA 6,1(6)
ST 6,44(4)
CR 6,7
BH 0810
SPACE 1
CL1 0(6),C'0'
RL 0500
CL1 0(6),C'9'
BH C110
MVN 0(1,8),O(6)
LA A,1(A)
SPACE 1
TM TC1,X'80'
RO D220
CH A'4=H'8'
BL D220
OI TC1,X'80'
NI TC3,X'EF'
NI TC2,X'FD'
SPACE 1
TM TC1,X'40'
RO D300
LA B,1(8)
SPACE 2
D300
TM TC1,X'20'
RO D400
L E+L0P
D310
LR F+E
M E=F+F'10'
A F+HOLD
TM TC1,X'10'
RO D330
ST F+L0P
NI L0P,X'03'
SR E,E
SLOE E,6
ST E+HOLD
L E+H0P
DI TC1,X'10'
R D310
FJECr
D330
ST F+H0P
NI TC1,X'EF'
R D200
SPACE 2
D400
CH A'=H'2'
RH C110
L F+EXP
M E=F+F'10'
A F+HOLD

CHECK THE DIGIT COUNT...

BR. AROUND IF .LT. 0.

DISCNT. THE DIGIT COUNT.

ALLOW LONG REAL STORAGE.

FORBID AN E IN A LONG REAL.

INCR. THE FRACT. DIGIT COUNT.

BUILD UP THE LONG PRIMITIVE...

***ZERO BIT 3.

CHECK THE DIGIT COUNT...

BR. TO TROUBLE IF .GT. 2.
ST F,EXP
B D200
SPACE 2
D500 CLI 0(6),C','
RE D600
SPACE 1
SR 1,1
LA C$,5200
LA E,4
LA F,20
D510 CLC 0(1,6),OIC
RE D700(1)
LA C$,1IC
RXLE 1,E,D510
B C110
SPACE 2
D600 TM TC1,X'08'
BO INT
SPACE 1
TM TC1,X'04'
BO D620
SPACE 1
A B,EXP
D610 NI TC3,X'8F'
SPACE 1
SLL B,1
ST B,EXP
B FLT
SPACE 1
D620 S B,EXP
RM D630
B D610
D630 LPR B,B
B D611
SPACE 2
D700 B D810
B D820
B D830
B D840
B D850
B D860
FJECT
D810 NI TC3,X'7F'
B D600
D820 TM TC1,X'02'
EQ D821
B C110
D821 NI TC1,X'9D'
D825 NI TC1,X'7F'
B D200
... EDAT2640
... EDAT2650
... EDAT2660
... EDAT2670
... BR, OUT IF COMMA...
... EDAT2680
... EDAT2690
... EDAT26700
SET UP RC, RE, & RF...
... EDAT2710
... EDAT2720
... EDAT2730
CHECK FOR OTHER CHARS...
... EDAT2740
... BR, OUT AS REQ'D.
... EDAT2750
... EDAT2760
INCRC RC...
... EDAT2770
... OR PR TO TROUBLE...
... EDAT2780
... EDAT2790
D... EDAT2800
D... EDAT2810
D... EDAT2820
D... EDAT2830
D... EDAT2840
D... EDAT2850
COMP. THE SCALING FACTOR...
... ENABLE DOWNSCALING...
... EDAT2860
... EDAT2870
... EDAT2880
... EDAT2890
... EDAT2900
... EDAT2910
... EDAT2920
... EDAT2930
... EDAT2940
... EDAT2950
... EDAT2960
... EDAT2970
... EDAT2980
... EDAT2990
... EDAT3000
... EDAT3010
... EDAT3020
... EDAT3030
... EDAT3040
... EDAT3050
... EDAT3060
BLANK...
... EDAT3070
... EDAT3080
... EDAT3090
... EDAT3100
... EDAT3110
... EDAT3120
ZERO BIT 16...
... EDAT3130
... EDAT3140
... EDAT3150
... EDAT3160
... EDAT3170
... EDAT3180
ALLOW FRACT. DIGIT COUNTING...
... FORBID 2,'5 IN THE P-PART.
... EDAT3130
... EDAT3140
... EDAT3150
... EDAT3160
... EDAT3170
... EDAT3180
ALLOW FLOATING.
... EDAT3130
<table>
<thead>
<tr>
<th>Address</th>
<th>Type</th>
<th>Data</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>D830</td>
<td>TM</td>
<td>TC1,'X'01'</td>
<td>7,0</td>
</tr>
<tr>
<td>D831</td>
<td>BO</td>
<td>D834</td>
<td>EDAT3190</td>
</tr>
<tr>
<td>D832</td>
<td>TM</td>
<td>TC2,'X'80'</td>
<td>8,1</td>
</tr>
<tr>
<td>D833</td>
<td>BO</td>
<td>D832</td>
<td>EDAT3200</td>
</tr>
<tr>
<td>D834</td>
<td>R</td>
<td>C110</td>
<td>EDAT3210</td>
</tr>
</tbody>
</table>
| D835    | NI   | TC2,'X'6F' | FORBID TWO 'S IN THE P-PART...
| D836    | CH   | A='H'0' | ALSO, & E IN THE P-PART. |
| D837    | RH   | C110   | EDAT3220 |
| D838    | B    | D200   | EDAT3230 |
| D839    | SPACE| 1      | EDAT3240 |
| D840    | TM   | TC2,'X'40' | (9,1) |
| D841    | BO   | D835   | EDAT3250 |
| D842    | R    | C110   | EDAT3260 |
| D843    | NI   | TC2,'X'67' | FORBID TWO 'S IN THE E-PART...
| D844    | CH   | A='H'0' | ALSO, & E IN THE E-PART. |
| D845    | RH   | C110   | EDAT3270 |
| D846    | B    | D833   | EDAT3280 |
| D847    | SPACE| 1      | EDAT3290 |
| D848    | TM   | TC2,'X'20' | (10,0) |
| D849    | BO   | D843   | EDAT3300 |
| D850    | R    | C110   | EDAT3310 |
| D851    | NI   | TC2,'X'87' | FORBID TWO 'S IN THE E-PART...
| D852    | CH   | A='H'0' | ALSO, & E IN THE E-PART. |
| D853    | RH   | C110   | EDAT3320 |
| D854    | B    | D833   | EDAT3330 |
| D855    | SPACE| 1      | EDAT3340 |
| D856    | TM   | TC2,'X'08' | (12,1) |
| D857    | BO   | D844   | EDAT3350 |
| D858    | R    | C110   | EDAT3360 |
| D859    | NI   | TC1,'X'FB' | ALLOW NEG. EXP. |
| D860    | CH   | A='H'0' | FORBID & E IN THE E-PART...
| D861    | RH   | C110   | EDAT3370 |
| D862    | B    | D833   | EDAT3380 |
| D863    | EJECT|        | EDAT3390 |
| D864    | TM   | TC2,'X'04' | (13,1) |
| D865    | BO   | D851   | EDAT3400 |
| D866    | R    | C110   | EDAT3410 |
| D867    | NI   | TC2,'X'F9' | FORBID TWO 'S IN AN ITEM...
| D868    | CH   | A='H'0' | AND D & E IN AN ITEM. |
| D869    | RH   | C110   | EDAT3420 |
| D870    | B    | D825   | EDAT3430 |
| D871    | SPACE| 1      | EDAT3440 |
| D872    | TM   | TC2,'X'02' | (14,1) |
| D873    | BO   | D861   | EDAT3450 |
| D874    | R    | C110   | EDAT3460 |

*EDAT3250 *EDAT3260 *EDAT3270 *EDAT3280 *EDAT3290
*EDAT3300 *EDAT3310 *EDAT3320 *EDAT3330 *EDAT3340
*EDAT3350 *EDAT3360 *EDAT3370 *EDAT3380 *EDAT3390
*EDAT3400 *EDAT3410 *EDAT3420 *EDAT3430 *EDAT3440
*EDAT3450 *EDAT3460 *EDAT3470 *EDAT3480 *EDAT3490
*EDAT3500 *EDAT3510 *EDAT3520 *EDAT3530 *EDAT3540
*EDAT3550 *EDAT3560 *EDAT3570 *EDAT3580 *EDAT3590
*EDAT3600 *EDAT3610 *EDAT3620 *EDAT3630 *EDAT3640
*EDAT3650 *EDAT3660 *EDAT3670 *EDAT3680 *EDAT3690
*EDAT3700 *EDAT3710 *EDAT3720 *EDAT3730
FORBID TWO F'S IN AN ITEM...
AND E & D IN AN ITEM.

LOAD THE LONG PRIMITIE...
& CHECK THE H-ORDER PART.
... BR. TO TROUBLE IF TOO LARGE.
LINK UP THE PARTS...
... & R-SHIFT IT ALL INTO RF.

MAKE THE RESULT NEG. IF REQ'D.
CHECK FOR PRECEDING ERRORS...
... BR. TO AVOID DATA LOADING.
STASH THE INTEGER WHERE REQ'D.
INCR. R3.

FLOAT THE LONG PRIMITIE...
... Link up the parts...
... & SHIFT IT ALL INTO RF.

CHECK THE FLOATED RESULT...
... BR. OUT TO AVOID SCALING.
... & SCALE AS REQ'D...

MAKE THE RESULT NEG. IF REP'D.
SPACE 1

RL15
CH C,=H'600'
RH C110
MD 2,0(C,1)
SPACE 1

RL20
TM TC3,X'20'
RO RL30
LND R,2,2
SPACE 1

RL30
TM TC3,X'10'
DO RL50
C 9,72(4)
RE IN30
STD 2,0(3)
LA 3,8(3)
B IN30
SPACE 2

RL50
LTD R,2,2
RZ RL55
STD 2,0KD
NC HOP,=X'FF000000'
NC LOP,=X'80000000'
AD 2,0KD
C 9,72(4)
RE IN30
STE 2,0(3)
LA 3,4(3)
B IN30

* TITLE 'EDATA-H DATA PROC. SECTION'
* * *

SPACE 1

HH
SR A, A
CH CLB, CLB
DI H510, L,X'FO'
SPACE 1

H200
LA 8,1(6)
ST 6,44(4)
CR 6,7
RH H600
SPACE 1

CLI 0(6), C', '
RL H300
BE H500
CLI 0(6), C', '
CL H110
CLI 0(6), C', '
BH C110
MVN 0(1,8), 0(6)
LA A, A
SPACE 1

L F, LOP
M E, =F'10'
A F, H0L1
CH F, =H'32767'
RH C110
ST F, LOP
B H200

SPACE 1
H300 CLI 0(6), C'
BE H600
CLI 0(6), C++,
BE H410
CLI 0(6), C-,,
BE H400
R C110
SPACE 1
H400 NI H510 +1, X'OF',
DISABLE THE BR. AT H510.
H410 CH A, = H'0'
CHECK FOR SIGN EMBEDMENT...
... BR. TO TROUBLE IF EMBEDDED.

H500 C 9, 72(4)
BE H530
LH B, LOP + 2

H510 BC 15, H520
**
LNR B, B
SET SIGN MINUS IF REQ'D.
H520 STH B, 0(3)
STORE THE H-INTEGER.
LA 3, 2(3)
INCR. R3.
H530 BC 15, HH
**
DI H530 +1, X'FF',
ENABLE THE BR. AT H530.
B BLNK

SPACE 1
H600 NI H530 +1, X'OF',
DISABLE THE BR. AT H530.
B H500

TITLE "EDATA-X DATA PROC. SECTION"
SPACE 1
*

SPACE 1
XX SR A, A
ZERO R8, CL8
XO CL8, CL8
ZERO LOP & HOLD.
SPACE 1
X200 LA 6, 11(6)
INCR., SAVE, & CHECK R6...
ST 6, 44(4)
***
CR 6, 7

H520 X500
*** BR. OUT IF PAST CARD END.
SPACE 1
CLI 0(6), C',
CHECK THE DATA FIELD CHAR...
BE X400
***
CLI 0(6), C'0',
***
BL X300
***
CLI 0(6), C'9',
***
BH C110
*** BR. TO TROUBLE IF .GT. 9.
MWN 0(1, 8), 0(6)
MOVE THE NUMERIC TO 'HOLD'.
L B, HOLD
SPACE 1
X220 LA A, 11A
INCR. & CHECK RB...
CH A, = H'8'
***
RH C110
*** BR. TO TROUBLE IF .GT. 8.
SPACE 1
L CL10
BUILD UP THE X-FORMATTED DATA...
51

SLL C,4
OR C,8
ST C,LOP
R X200

SPACE 1

X300
CLI 06),C'4' "RECHECK THE DATA FIELD CHAR..."
RE X500
CLI 06),C'A'
BL C110
CLI 06),C'F'
BH C110
MVN 01]8),06)
L B,HOLD
AH B,'H'9'
R X220
SPACE 1

X400
C 9,77(4)
BE X410
SPACE 1
L B,LOP
ST B,01(3)
LA 3,4(3)
SPACE 1

X410
BC 15,XX **
D L,03
B,L,0F
SPACE 1

X500
NI X410+1,X'FO'
B X400
TITLE 'DATA-ERASABLE STORAGE AND CONSTANTS.'
SPACE 1

DWD
CL16
HOP
CL8
LDP
HOLD
LD8
EX
SPACE 1

TCW
TC1
TC2
TC3
TC4
SPACE 1

S100
DC C'
DC C'C'
DC C'D'
DC C'H'
DC C'R'
DC C'X'
SPACE 1

S200
DC C'
| DC   | C++  |
| DC   | C++  |
| DC   | C+  |
| DC   | C*D  |
| DC   | C+E  |

**SPACE 1**

**LTORG**

**TITLE 'EDATA-CSECTS LFH2 AND LFH3.'**

**SPACE 1**

<table>
<thead>
<tr>
<th>LFH2</th>
<th>CSECT</th>
</tr>
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<tbody>
<tr>
<td>FWD</td>
<td>DS F</td>
</tr>
<tr>
<td>R0</td>
<td>DS F</td>
</tr>
<tr>
<td>R7</td>
<td>DS 4F</td>
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<tr>
<td>R1</td>
<td>DS F</td>
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<td>R2</td>
<td>DS F</td>
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<td>R9</td>
<td>DS F</td>
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<td>RY</td>
<td>DS 3F</td>
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<tr>
<td>N3</td>
<td>DS F</td>
</tr>
<tr>
<td>N4</td>
<td>DS F</td>
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</tbody>
</table>

**CARD** DS CLBO +88

**BLANK** DC CL4  

**R30** DS F +172

**PSW** DS 2F +176

**K3** DS 2H +184

**CBLW** DS 4400F +188

**SPACE 1**

<table>
<thead>
<tr>
<th>LFH3</th>
<th>CSECT</th>
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</thead>
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**TABLE OF 10**

<table>
<thead>
<tr>
<th>TENS</th>
<th>DC</th>
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<tbody>
<tr>
<td>DC</td>
<td>D'1.0E+0,1.0E+1,1.0E+2,1.0E+3,1.0E+4,1.0E+5</td>
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<tr>
<td>DC</td>
<td>D'1.0E+6,1.0E+7,1.0E+8,1.0E+9,1.0E+10</td>
</tr>
<tr>
<td>DC</td>
<td>D'1.0E+11,1.0E+12,1.0E+13,1.0E+14,1.0E+15</td>
</tr>
<tr>
<td>DC</td>
<td>D'1.0E+16,1.0E+17,1.0E+18,1.0E+19,1.0E+20</td>
</tr>
</tbody>
</table>

**EJECT**

| DC   | D'1.0E+21,1.0E+22,1.0E+23,1.0E+24,1.0E+25  |
| DC   | D'1.0E+26,1.0E+27,1.0E+28,1.0E+29,1.0E+30  |
| DC   | D'1.0E+31,1.0E+32,1.0E+33,1.0E+34,1.0E+35  |
| DC   | D'1.0E+36,1.0E+37,1.0E+38,1.0E+39,1.0E+40  |
| DC   | D'1.0E+41,1.0E+42,1.0E+43,1.0E+44,1.0E+45  |
| DC   | D'1.0E+46,1.0E+47,1.0E+48,1.0E+49,1.0E+50  |
| DC   | D'1.0E+51,1.0E+52,1.0E+53,1.0E+54,1.0E+55  |
| DC   | D'1.0E+56,1.0E+57,1.0E+58,1.0E+59,1.0E+60  |
| DC   | D'1.0E+61,1.0E+62,1.0E+63,1.0E+64,1.0E+65  |
EXEC ASSEMBLER, PARM='LOAD,DECK'

SPICE TITLE '...DIAGNOSTIC SUPPRESSOR SUBPROGRAM...

9/17/68 - L.F.H.
MOD. 3/07/69 - L.F.H.

USAGE...CALL SPIE( LDW )
WHERE LDW IS A PARAMETER CALLING FOR SETTING A NEW P.I.E. OR RESETTING THE OLD P.I.E. DEPENDING ON WHETHER IT IS .GT. ZERO OR .LT. ONE.
ONE OF THE P.I.E. HAS BEEN SET, IT REMAINS IN THE SYSTEM.
EFFECT ON SUBSEQUENT CALLS ON SPIE WITH LDW .GT. ZERO: THE OLD P.I.E. IS RESET IF A SUBSEQUENT CALL ON SPIE HAS LDW .LT. ONE.

...GOOD LUCK-L.F.H.

SPIE CSECT
ENTRY YECHR,1
USING *,15
R S100
DC CL6'SPIE '
SAREA DS 18F
S100 STM 14,12,12(13)
LA 12,SAREA
ST 13,6(12)
ST 12,8(13)
LR 13,12
BALR 2,0
USING *,2
DROP 15
L 3,0(1)
L 4,0(1)
C 4,=F*1'
RL S300
L 4,FLAG
C 4,=F*1'
RE S200
MVC FLAG,=F*1'
SPIE YECHR((1,15))
ST 1,R1
S200 L 13,4(12)
LM 14,12,12(13)
MVI 12(13),K*TF'
YECH RCR 15,14
S300 L 4,FLAG
C 4,=F*0'

...
ENTRY TTIME,T1
USING *,15
B S100
DC X'05'
DC CL,STIME'
STM 14,12,12(13)
LA 15,TIME-STIME(15)
USING TTIME,15
NI T102+1,X'OF'
MVC T2,T1
B T100

TTIME
STM 14,12,12(13)
L 3,0(1)
L 4,T1
QI T102+1,X'OF'

T100
LR 2,15
USING TTIME,2
DROP 15
LA 12,SAREA
ST 13,4(12)
ST 12,8(13)
LR 13,12

T102
DC 0,T200

T103
STIMER TASK,R1,TUINtvL=T2
T105
LM 14,12,12(13)
BCR 15,14

T200
TIMMER CANCEL
L 4,T1
SR 4,0
ST 0,T1
ST 4,0(3)
B T105
```
RTN ABEND 4095, DUMP, STEP
   EJECT
*
T1 DC F'138461538' T-UNITS=60 MINUTES.
T2 DS F
SAREA DS 18F
END
/
// EXEC ASSEMBLR PARM='LOAD,DECK'
// SDCRF, SYSSIN DD *
DATA TITLE "...INITIAL DATA IN CSECTS DATA AND CONS..." DATA0010
*
* 2/21/69 - L.F.H.
* MOD. 9/03/69 - L.F.H.
DATA CSECT
*
Z DC 240D'U.0',80C' *
*
...PROGRAM CONTROL PARAMETERS...
*
NEQ1 DC F'3' NO. OF 1ST PHASE DERIV. EQ'S.
NEQ2 DC F'6' NO. OF 2ND PHASE DERIV. EQ'S.
J1 DC F'0' BR. PARM. SET BY SUBP. SETH FOR SUBP. RK.
J2 DC F'5' 1ST PHASE PRINT FREQ.
J3 DC F'5' H ADJUST. PARM.
J4 DC F'0' CASE NO.
J5 DC F'0' 2ND PHASE EULERIAN POLE INDICATOR.
*
...CONVERSION CONSTANTS...
*
CONS CSECT
TWPI DC D'6.2831853071795864769' 2*PI DATA0220
CRTD DC D'57.29577951308232' RADIANS TO DEGREES DATA0240
CDTR DC D'1.745329251994330E-2' DEGREES/T RADIANS DATA0250
P1D2 DC D'1.570796326794897' PI/2.0 DATA0260
P1D4 DC D'7.853981633974483' PI/4.0 DATA0270
END
/
// EXEC LINKGO
// GO.SYSUDUMP DD SYSUT=A,SPACE=(TRKt(8))
// GO.DATA5 DD *
/// JAVELIN ROC STUDY DATA - PART 1.1...
***** NOMINAL DATA WITH RELEASE AT VARYING GAMMA ANGLES.
***** 1920 C'...JAVELIN ROC STUDY PART 1.1 - WU ALIGNMENT...
  8 D4.8821250-4.9.500 HO,G1.
  80 D.80416760,428600,1.45600 D1,J2,D3.
 136 D3.5033300 DB.
 160 D.4D0.,117800.,346600.,42D0 M,JCY1,JCY2,JCY3.
 192 D000.,0321900,0D0 JCY4,JCY5,JCY6.
 240 D7.5D0 JCY7.
 328 D6D1,5D-6 Y1,Y0PS.
 352 D51S0 AX1.
```
EFFECT OF CLAMSHELL DENSITY CHANGE TO 1.1 OF NOMINAL.

160  D400,.129600,.391300,.46200  M,JCY1,JCY2,JCY3.
192  D000,.0354100,000  JCY4,JCY5,JCY6.
328  D601,50-6  YT,IEPS.
2012  D4  J2-PRINT FREQ.
3170  R  JROC0140
2012  D32768  J2-PRINT FREQ.
328  D301  YT.
777  R  JROC0150
328  D1.501  YT.
777  R  JROC0170
328  D12.500  YT.
777  R  JROC0180
328  D101  YT.
777  R  JROC0190

EFFECT OF CLAMSHELL DENSITY CHANGE TO 0.9 OF NOMINAL.

160  D3600,.106000,.311900,.47800  M,JCY1,JCY2,JCY3.
192  D000,.0289700,000  JCY4,JCY5,JCY6.
328  D601  YT.
2012  D4  J2-PRINT FREQ.
4170  R  JROC0170
2012  D32768  J2-PRINT FREQ.
328  D301  YT.
707  R  JROC0180
328  D1.501  YT.
707  R  JROC0210
328  D12.500  YT.
707  R  JROC0220
328  D101  YT.
707  R  JROC0230
007  R  JROC0240
/*  JROC0250
1808 CARDS
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